Volume 7, No. 3 **July 1952**

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ALSO: Land Characteristics and Land Use in the South Tihama—Saudi Arabia *by Howard J. Ferris;* Walkways Improve Grazing Distribution *by Robert E. Williams;* Soil and Water Conservation Glossary—Section III; Book Reviews and Field Notes and Comments.

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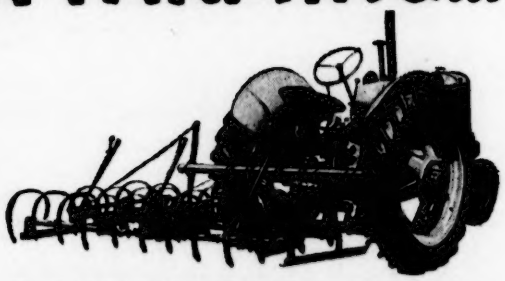

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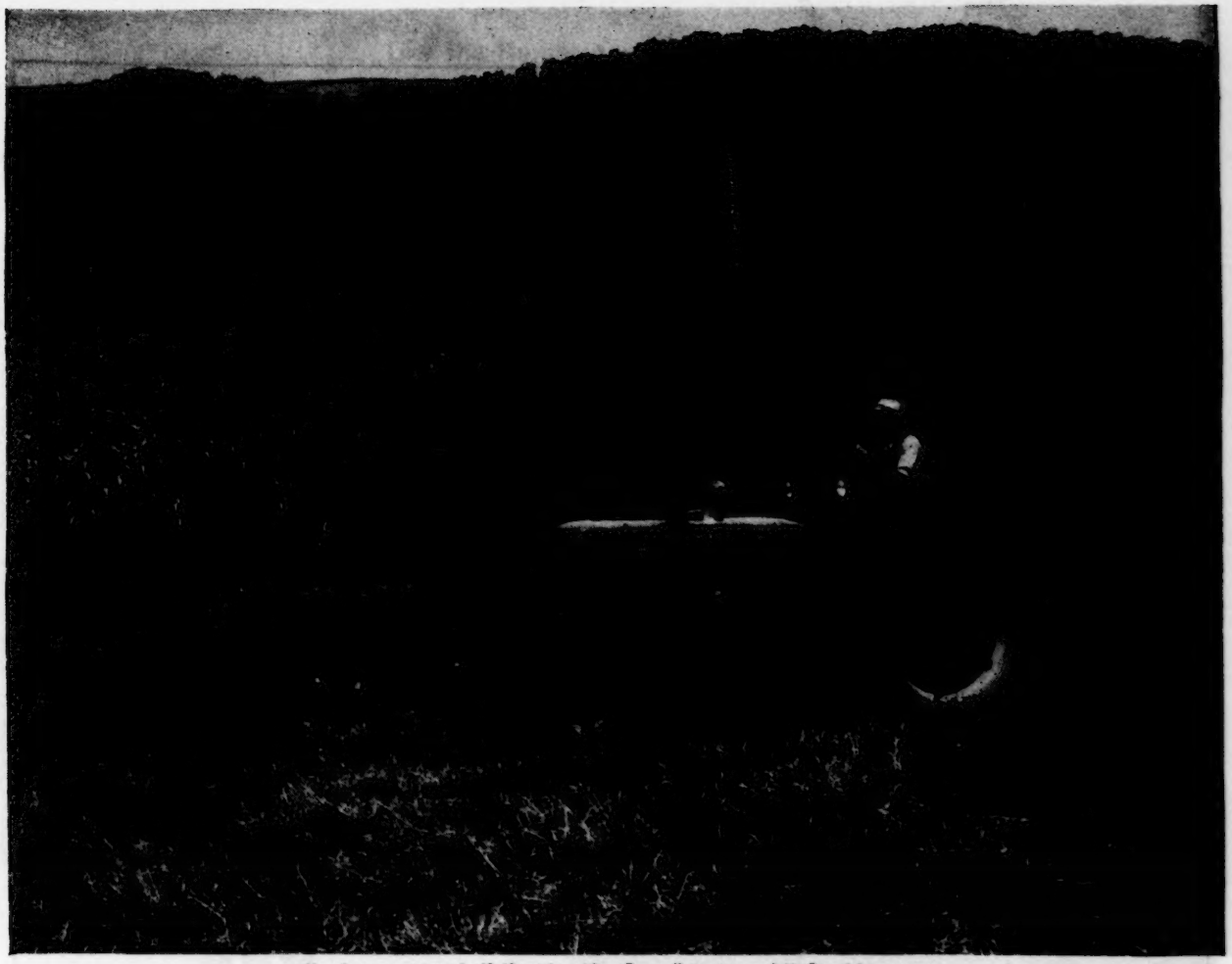

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Journal of SOIL AND WATER CONSERVATION

VOLUME 7
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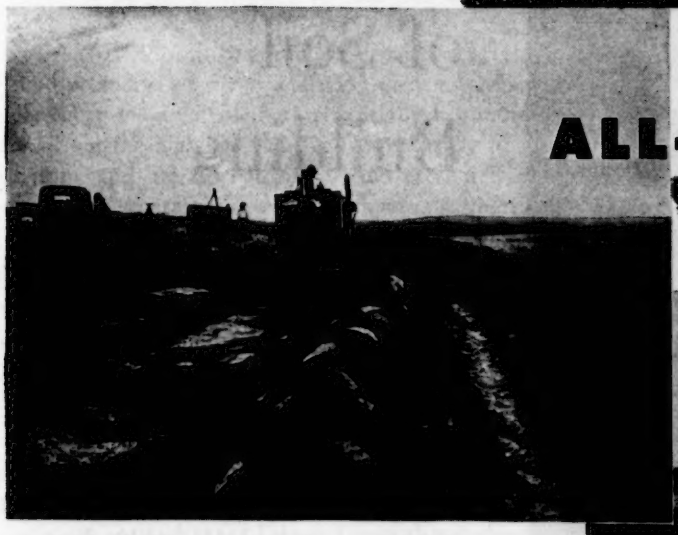

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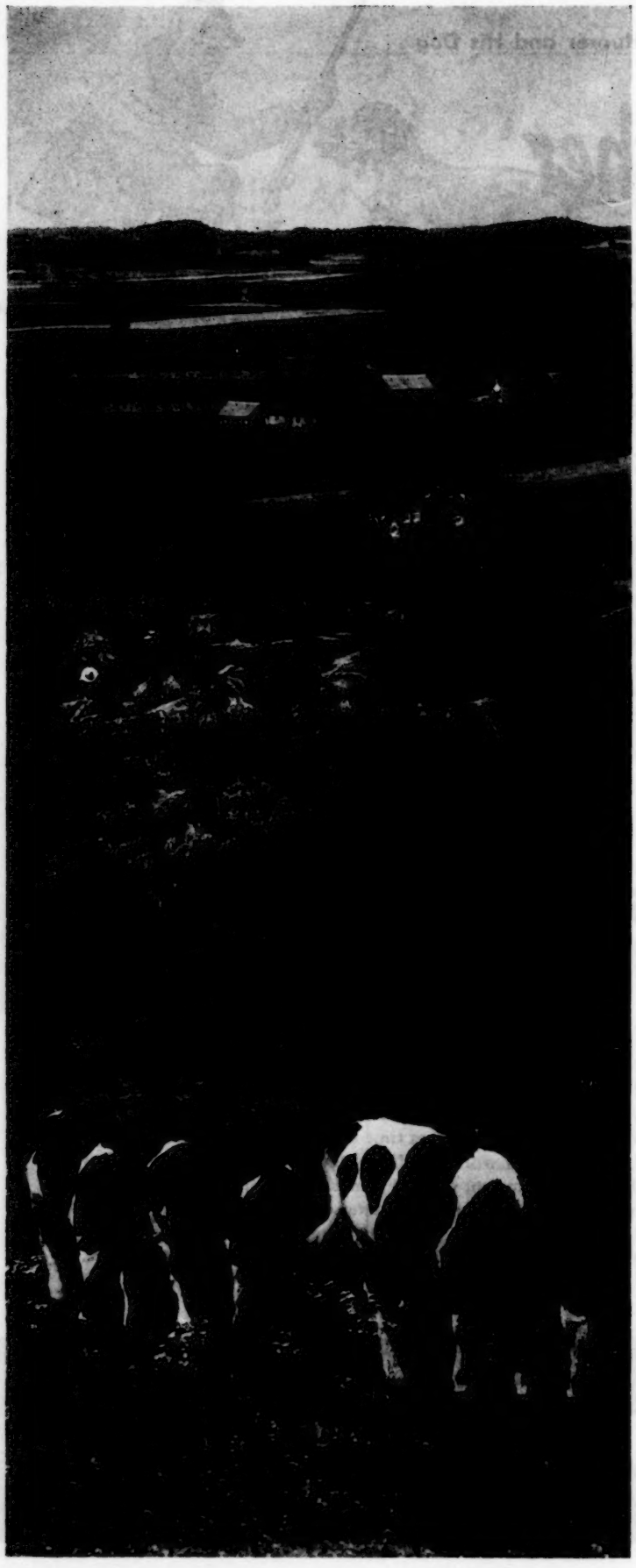

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Potential "Dust Bowl" in the Making

C. A. RECHENTHIN

Drought, large acreages of land planted to cotton with resulting unprotected soils, and high winds have combined to create a serious condition in the southern end of the High Plains of Texas. Fortunately, winds subsided in intensity during early June, but drought continues to hamper the cropping in the rich cotton area.

FARMERS, soil conservation district supervisors, and field personnel of the agricultural agencies are anxiously watching the area, for here potentially is another "dust bowl" in the making. The soils are largely of a sandy nature, and are susceptible to wind erosion if not protected by vegetative cover. Without rain, there is little chance to get the cover.

Conditions in the area during February, March and April were so bad that some people insist that they were the worst ever. Highways and railroad tracks at some points were covered, requiring maintenance crews to remove sand from rights-of-way. During some periods, highways in the area were closed because blowing dust and sand made visibility so bad that it was dangerous to travel them. A number of accidents necessitated the closing of the highways during the high wind periods as much as six hours. Dunes accumulated along fences and in fields. In some fields, the topsoil was removed down to the hard subsoil or plow sole.

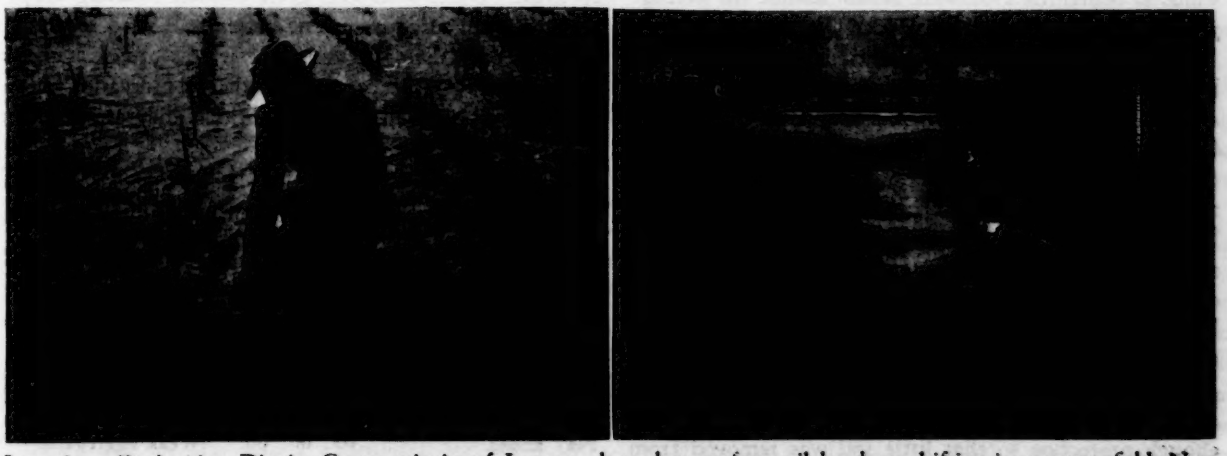
Reports prepared by field personnel of the Soil Conservation Service, based on observations and field checks, revealed that up to April 16, 1,212,000 acres of cropland had been damaged to a moderate or severe degree by wind erosion. Many times that acreage had been damaged to a lesser degree.

Drought has no doubt been responsible in large part for the existing conditions. Below normal rainfall occurred in 1951 in the southern High Plains from Lubbock southward. Insufficient moisture occurred in most of the area for making good crops under dryland farming. In some parts, crop failures occurred. It is reported that as little as 2.6 inches fell in some parts in the Big Spring-Midland area during the year. Normal for the area is about 18 to 20 inches annually.

Following this extremely dry year, fall and winter moisture was inadequate for satisfactory tillage practices or establishing of cover crops. Big Spring reported 0.82 inch in the 5½ month period, November 1, 1951 to April 15, 1952. Lamesa reported 0.99 inch, and Lubbock a big 1.90 inches for the same period. Cover crops of wheat and barley failed after coming up to good stands on September rains.

Another contributing factor to the erosion damages

C. A. Rechenthin, a memebr of the SCSA, is a zone conservationist with the Soil Conservation Service. He is located at Fort Worth, Texas.



Lett. Jesse D. Jenkins, District Conservationist of Lamesa, shows how surface soil has been drifting in a cotton field. Note the bare stalks which offer almost no protection. About 90 per cent of the southern end of the High Plains was planted to cotton in 1951. Drought, winds and poor cover took a severe toll of the sandy soils in the area. Right. R. M. Marshall of Fort Worth, Regional Soil Scientist, shows what remains of a terrace built in a field last year. Almost all the soil blew away after a cover crop of small grain failed due to drought.

Left. There are bright pictures too. This is a sandy, severely blown field in the Cochran-Yoakum-Terry Soil Conservation District that was retired to grass. The weeping lovegrass in which the three men are standing has controlled blowing and will furnish a lot of good grazing. Right. R. M. Marshall here shows how the grain sorghum has controlled blowing. There is only slight evidence of blowing in this field on the Soil Conservation Experiment Station near Brownfield, whereas adjoining fields of similar soils were blowing badly.

was the large area not protected by vegetative cover. Soils subject to wind erosion must be protected by growing cover or residues on the surface. In 1951, a large part of the area was planted to cotton, as much as 90 per cent of the land in some districts. Cotton after frost loses its leaves, and only the bare stalk remains. This affords almost no cover on the surface. Harvesting by mechanical strippers contributed by removing the little residue that remained.

On top of this, February started out with some high winds, which increased in intensity. By mid-March, winds of unusual intensity were blowing almost daily. Lubbock's morning paper, the Avalanche, reported that winds in March of 1952 were almost double the average velocity of those in March 1951.

In the midst of the severe conditions, there were a few bright pictures. The response of grasses planted on some severely blown fields in the past few years by the Soil Conservation Service and by farmers cooperating with the soil conservation districts was excellent. Notable is the growth of the blue panicum and weeping and sand lovegrass. Some fields previously damaged now show no evidence of wind erosion under grass, though some of the grass actually made little growth in 1951 due to low rainfall. Some of the blue panicum and lovegrasses made enough growth to furnish considerable grazing as well as cover.

Grain sorghum residue, left on the surface, furnished enough protection so that little soil was removed from the fields, although some shifting occurred. In fact, some sorghum fields actually accumulated soils blown from adjoining unprotected cropland.

Farmers resorted to emergency tillage to bring clods to the surface to stop the wind blowing. A small amount of moisture in February made this possible, but by mid-March the moisture was gone and most farmers were unable to till again until more moisture occurred. Many farmers deep-plowed their land, bringing up sandy clay subsoil in clods, with good results where the heavy subsoil was within reach of the plow.

Agricultural agencies and subsoil conservation districts are making plans to combat the erosion hazard. Rains, when they come, no doubt will do much to get the conditions in check. Most important, of course, is fitting the treatment to the needs and capabilities of the land. Highly vulnerable soils, for example, would be retired to grass. Other soils can grow erosion resisting crops such as grain sorghums. The better soils need sorghum in strips or in fields to resist the wind's attack. These are the keys to the problem. Other conservation measures must be woven into the fabric as they are needed.

Errata—April Issue

The diagram showing the action of Krilium on Page 63 of the April 1952 issue of the JOURNAL was in error. It should read—

Diagrammatically, the action of Krilium (12) may be shown as follows:

Experimentally	Soil Clay Particles	Soil Condition
Clay suspension	0 0 0 0 0 0	Poorly aggregated
Na^+ added	00 00 00	Weak aggregates formed, easily dispersed.
Polyanion (*Krilium*) added	⌢ ⌢ ⌢ 00 00 00 ⌣ ⌣ ⌣	Aggregates stabilized by bridges. Aggregates strong.

Some Relationships of Precipitation and Soil Loss on Small Agricultural Watersheds

F. R. DREIBELBIS

A knowledge of the relation of certain rainfall characteristics to soil erosion is needed to aid in the solution of soil and water conservation problems. A study of such relationships has revealed that the monthly amounts of rain falling at high rates of intensity are greatest in June and July followed by May, August and September for the Coshocton, Ohio area. There appears to be little correlation of annual and monthly precipitation with soil erosion. A direct correlation was revealed when amounts of rain falling at the higher intensities were compared to amounts of erosion. Soil conservation practices have reduced soil loss to a considerable extent as shown by data obtained from paired small 2-acre watersheds for the period 1939-1950.

BECAUSE OF THE WIDESPREAD concern and interest in soil erosion, many studies in various parts of the country are being conducted to determine the causes of erosion and what can be done to prevent or reduce these losses. In humid areas, rainfall is commonly regarded as the principal cause. It is the purpose of this paper to show the relation of certain rainfall characteristics to erosion as observed at the Hydrologic Research Station of the U. S. Soil Conservation Service near Coshocton, Ohio. The effect of conservation farming practices on these relationships is also illustrated.

Many investigations have shown that the bulk of soil loss occurs from land in row crops. The Coshocton data, which were obtained from small watersheds about two acres in area, also reveal this fact. The erosion values presented herein are limited to the corn years of a four-year rotation of corn, wheat, meadow, meadow.

Relation of Amounts and Rates of Rainfall to Erosion

In regions where the annual precipitation varies from 31 to 47 inches as it has in 14 years of record at this station, there appears to be no value in attempting to correlate annual precipitation with annual erosion. For example, with 39.61 inches of precipitation in 1941, there were 2.1 tons of soil loss per acre from a corn watershed, whereas, in 1945 with 45.36 inches of precipitation there was only 0.4 ton soil loss from the same area. It is possible to have a large amount of annual rainfall with very little erosion while it is also possible to have a small quantity of annual rainfall with a great deal of erosion.

A comparison of monthly rainfall and erosion (Table 1) shows a better correlation than the annual values. It is evident, however, that a high value of monthly rainfall does not necessarily mean that the erosion value will also be great. In September 1944, rainfall of 1.85 inches resulted in 1.9 tons soil loss per acre on corn watershed 106. In September 1948, rainfall of 3.35 inches on this same area in corn resulted in 0.5 ton of erosion. In Table 1 the data also reveal that in September 1945, it was possible to have 9.29 inches of rain with almost no erosion.

The above comparisons indicate that it is necessary to know more about rainfall than annual, monthly, or even daily amounts in order to evaluate the rainfall factor in soil erosion studies. This led the author to assemble the rainfall data first into storm totals as shown in Table 2. These data show, for example, that storms of one inch or more occurred most frequently in May, June, and July. About 54 per cent of storms of one inch or more rainfall occurred in the five-month growing season, May to September. As over 80 per cent of the annual erosion usually occurs in this same period, a further analysis of the data is necessary.

Finally, the rainfall data were assembled in such a manner so as to show the effect of rainfall intensity on erosion. The amounts of rain that fell at rates greater than selected rate values were tabulated and summarized into monthly totals (Table 3). The total rain that fell at rates greater than zero is the total rainfall. For example, the average value for June of 5.13 inches is the total average rainfall (1937-1950) for that month. The value of 2.42 inches for June on the 1.0 inch per hour rate line is that portion of the June rainfall (1937-1950) that fell at rates over 1.0 inch per hour.

By further analyzing the data in Table 3, it can be

F. R. Dreibelbis, a member of the Soil Conservation Society of America, is Soil Scientist for the Hydrologic Research Station of the Soil Conservation Service at Coshocton, Ohio. *This article is a joint contribution of the Hydrologic Research Station and the Agricultural Experiment Station, Wooster, Ohio.*

The author wishes to express his appreciation to Mr. Lloyd L. Harrold, Project Supervisor, for valuable suggestions given in the preparation of the manuscript; also to Mr. Robert E. Youker, Agricultural Aid, for valuable assistance given.

Table 1.—Summary of data on precipitation, runoff, and soil loss on corn watersheds[1]

Year	Watershed No.	Practice	May			June			July			August			September			Total May-Sept.			Annual precipitation
			Soil type[2]	Rainfall	Runoff	Soil loss	Rainfall	Runoff	Soil loss	Rainfall	Runoff	Soil loss	Rainfall	Runoff	Soil loss	Rainfall	Runoff	Soil loss	Rainfall	Runoff	Soil loss	
1941	115	Poor	Mx	6.82	2.37	1,753	7.49	2.30	1,651	5.82	2.32	455	5.13	1.75	258	1.49	0.34	31	26.75	9.08	4,148	39.61
	123	Conservation	K	6.82	1.58	1,905	7.49	1.50	441	5.82	1.77	96	5.13	.96	52	1.49	.05	11	26.75	5.86	2,405	39.61
1942	110	Poor	K	4.71	.51	15,040	5.22	.02	38,595	2.20	.00	1,580	2.56	.06	140	2.57	.04	0	17.26	1.29	55,935	33.47
	103	Conservation	K	4.71	.50	968	5.22	.58	8,894	2.20	.02	0	2.56	0	0	2.57	0	0	17.26	1.10	9,862	33.47
1944	106	Poor	M	2.08	0	0	3.13	.44	*10,000	2.66	.28	3,814	4.98	1.64	12,445	1.85	.38	3,884	14.70	2.74	30,143	30.59
	121	Conservation	M	2.08	0	0	3.13	.35	*10,000	2.66	.17	4,027	4.98	1.46	13,914	1.85	.29	5,607	14.70	2.27	33,548	30.59
	188	Conservation (mulch)	M	2.08	0	0	3.13	.01	0	2.66	0	0	4.98	.71	476	1.85	.10	40	14.70	.82	516	30.59
1945	115	Poor	Mx	4.72	T	0	4.03	.14	170	2.63	0	0	1.01	0	0	9.29	1.50	576	21.68	1.64	746	45.36
	123	Conservation	K	4.72	0	0	4.03	T	12	2.63	0	0	1.01	0	0	9.29	.37	43	21.68	.37	55	45.36
1946	110	Poor	K	5.38	T	0	6.44	1.96	33,989	5.27	.08	3,083	2.36	.19	392	.66	0	0	20.11	2.83	37,464	37.33
	103	Conservation	K	5.38	T	0	6.44	1.79	7,786	5.27	.39	263	2.36	.03	6	.66	0	0	20.11	2.21	8,045	37.33
1947	118	Poor	C	6.21	.13	13	5.43	.90	1,704	2.83	.03	998	4.22	.88	39	3.10	.05	0	21.79	1.99	2,754	36.92
	119	Conservation	C	6.21	.03	4	5.43	.30	706	2.83	.01	38	4.22	.15	0	3.10	0	0	21.79	.49	808	36.92
1948	106	Poor	M	3.31	.03	0	4.85	1.60	31,183	3.44	.71	13,350	1.08	.06	445	3.35	.46	996	16.03	2.86	45,974	35.73
	121	Conservation	M	3.31	.03	0	4.85	.67	12,478	3.44	.41	3,105	1.08	0	0	3.35	.03	17	16.03	1.14	15,600	35.73
	188	Conservation (mulch)	M	3.31	0	0	4.85	.01	2	3.44	.05	51	1.08	0	0	3.35	0	0	16.03	.06	55	35.73
1949	115	Poor	Mx	2.80	.02	39	2.96	.01	0	7.85	1.66	2,670	2.60	.23	48	3.22	.05	10	19.43	1.97	2,767	37.64
	123	Conservation	K	2.80	0	0	2.96	0	0	7.85	.16	502	2.60	T	0	3.22	0	0	19.43	.16	502	37.64
1950	110	Poor	K	3.90	.64	9,942	1.86	0	0	6.96	1.80	25,324	2.15	.52	2,936	5.69	3.25	20,402	20.56	6.21	58,604	47.28
	103	Conservation	K	3.90	.42	5,240	1.86	0	0	6.96	1.08	4,894	2.15	.19	384	5.69	2.62	2,995	20.56	4.31	13,517	47.28
Total				39.93	6.26	34,844	41.41	13.18	157,671	39.66	11.60	64,246	26.09	8.83	31,535	31.22	9.53	34,612	178.31	49.40	322,908	.....
Total, poor practice				.....	3.70	26,827	.....	7.97	117,292	.....	7.54	51,274	.....	5.33	16,703	.....	6.07	25,899	.....	30.61	237,995	.....
Total, conservation practice				.....	2.56	8,017	.....	5.21	40,379	.....	4.06	12,972	.....	3.50	14,832	.....	3.46	8,713	.....	18.79	84,913	.....
Average, poor practice				.....	.41	2,981	.....	.89	13,032	.....	.84	5,097	.....	.59	1,856	.....	.67	2,878	.....	3.40	26,444	.....
Average, conservation practice				.....	.23	729	.....	.47	3,671	.....	.37	1,179	.....	.32	1,348	.....	.31	792	.....	1.71	7,719	.....
Average poor; tons per acre				.....	.....	1.49	.....	.....	6.52	.....	.....	2.85	.....	.....	.93	.....	.....	1.43	.....	.....	13.22	.....
Average conservation; tons per acre				.....	.....	.36	.....	.....	1.84	.....	.....	.59	.....	.....	.67	.....	.....	.40	.....	.....	3.86	.....
Average mulch; tons per acre				.....	.....	0	.....	.....	T	.....	.....	.03	.....	.....	.24	.....	.....	.02	.....	.....	.29	.....

[1] Precipitation and runoff expressed in inches; soil loss in pounds per acre.
[2] C, Coshocton silt loam; K, Keene silt loam; M, Muskingum silt loam; Mx, mixed soil types of M and K.
[3] Incomplete data—estimated.

seen that 87 per cent of the annual rainfall that fell at rates greater than 1 inch per hour occurred in the five-month period, May to September, which comprises most of the growing season. This value closely approximates the seasonal distribution of soil erosion.

The annual variations of rain falling at different intensities for the month of June are shown in Table 4. The annual variations for July are similar. During these two months much more rain falls at the higher intensities than any other months of the year. The variations in intensity from year to year are also illustrated in this table. From these data and those presented in Tables 2 and 3 it can be seen that for this locality the highest intensities and the greatest amounts of rainfall, as well as the largest number of storms, occur during the growing season, May to September, with the maximum occurring in June and July. It is well known that drop-size usually increases with rainfall intensity resulting in greater soil dispersion, soil packing, and reduced infiltration. The need for developing agricultural practices to meet this situation therefore is apparent. On row crops the soil is least protected and most vulnerable to damage by raindrop splash and surface sealing during the summer months when the crops need the most water. Practices that promote infiltration and thereby reduce surface runoff are enhancing the water economy of crop growth. Since we cannot control amounts and intensities of rainfall, means and methods must be developed for getting more of the water into the soil where it can do the most good and result in the least damage to the areas involved.

Influence of Conservation Practices on Runoff and Soil Loss

An example of the effectiveness of soil conservation practices in reducing soil and water losses is shown in the data collected from paired small watersheds which have been in a four-year rotation of corn, wheat, meadow, and meadow since 1941. Conservation practices involve contour cultivation and improved meadow crops, whereas, poor practices are straight row (across slope) cultivation and poor meadow crops. The monthly runoff and soil loss from these areas while in corn appears in Table 1. From these data it can be seen that conservation practices have reduced soil loss to a considerable extent. Data for watersheds 103 and 110 include three corn years in the rotation in which the soil loss was considerably lower each rotation on the conservation-practice watershed than on the poor-practice area. During the years 1944 and 1948 a comparison of mulched-corn watersheds with poor- and conservation-practice areas is shown. In 1944 the soil loss on the mulched area was

Table 2.—Monthly distribution of number of storms equal to or exceeding various amounts of rainfall for 14-year period 1937-1950

Precipitation equal to or exceeding	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Annual average
inches														
0.25	46	39	58	62	75	79	72	55	46	38	48	35	653	47
.50	24	19	35	30	48	49	42	30	24	23	23	17	364	26
.75	15	11	19	16	24	35	29	18	15	16	9	9	216	15
1.00	9	5	12	11	14	17	17	12	7	11	5	5	125	9
1.25	4	2	8	7	10	12	12	8	4	6	2	3	78	6
1.50	3	1	5	2	10	10	7	4	3	4	0	2	51	4
2.00	1	0	3	0	4	5	4	3	3	1	0	1	25	2
2.50	1	0	2	0	3	3	1	1	1	1	0	1	14	1
3.00	1	0	1	0	0	1	0	0	1	0	0	0	4	<1
3.50	1	0	0	0	0	1	0	0	1	0	0	0	3	<1

Table 3.—Average monthly amounts of rain that fell at rates greater than various rate values, 1937-1950, Gage Y102[1]

Selected intensities (in/hr.)	Monthly amounts of rain that fell at rates greater than that shown in Column 1												Annual
	Jan. In.	Feb. In.	Mar. In.	April In.	May In.	June In.	July In.	Aug. In.	Sept. In.	Oct. In.	Nov. In.	Dec. In.	Total In.
0	2.90	2.19	3.55	3.46	4.54	5.13	4.64	3.13	2.76	2.45	2.41	2.10	39.26
.3	.24	.21	.77	.76	2.26	3.42	3.47	2.00	1.48	.73	.33	.16	15.83
.5	.16	.12	.63	.51	1.86	3.12	3.23	1.80	1.31	.47	.19	.10	13.50
1.0	.07	.05	.40	.25	1.33	2.42	2.67	1.31	.95	.31	.09	.06	9.91
1.5	.03	.04	.26	.18	1.00	1.98	2.11	.94	.74	.19	.06	.03	7.56
2.0	.025	.02	.19	.11	.72	1.48	1.48	.69	.53	.16	.04	.01	5.45
3.0	.015	.004	.06	.025	.39	.89	.78	.36	.19	.09	.02	.004	2.83
4.0	0	0	.006	.02	.27	.56	.48	.18	.03	.06	.005	0	1.61
5.0	0	0	0	.02	.15	.42	.28	.09	.015	.015	0	0	.99
6.0	0	0	0	.01	.07	.24	.15	.06	.01	.015	0	0	.55
7.0	0	0	0	.01	.03	.09	.09	.03	.01	0	0	0	.26

[1]The term "amounts of rain falling at rates greater than selected values" should not be confused with the concept of all the rain falling at these rates. For example, if the rainfall rate of over three inches per hour lasted for six minutes the amount falling at rates exceeding 1.0 inch per hour would be $(3\text{-}1) \times \frac{6}{60} = 0.2$ inch. Since part of the rainfall may greatly exceed the three-inch per hour rate, a portion of the amount would fall at less than one inch per hour.

Table 4.—Total amount of rain that fell at rates greater than selected rate values for the month of June 1937-50, Gage Y102

Year	Amount of rain falling at rates greater than—										
	in/hr 0	in/hr 0.3	in/hr 0.5	in/hr 1.0	in/hr 1.5	in/hr 2.0	in/hr 3.0	in/hr 4.0	in/hr 5.0	in/hr 6.0	in/hr 7.0
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1937	8.86	6.01	5.49	4.60	3.41	1.80	1.52	1.26	1.26	1.26	.....
1938	4.27	3.07	2.85	2.00	2.00	1.16	.70	.27	.....	.....	.....
1939	6.56	3.43	2.76	1.51	1.10	.71	.34	.34	.20	.....	.....
1940	7.12	5.07	4.33	3.44	2.67	2.21	1.67	.92	.40	.14	.14
1941	7.22	5.50	5.12	3.81	2.93	2.46	1.18	.94	.78	.48	.48
1942	5.83	4.20	3.62	2.87	2.66	2.30	1.63	.90	.83	.15	.15
1943	2.64	2.36	2.33	2.03	1.83	1.44	.75	.75	.75	.22	.....
1944	3.48	2.48	2.35	1.76	1.34	1.02	.41	.21	.21	.12	.12
1945	3.93	2.29	2.06	1.76	1.51	.89	.50	.....	.....	.....	.....
1946	6.44	3.55	3.44	3.07	2.67	2.48	1.68	.71	.30	.....	.....
1947	5.72	3.82	3.35	2.48	1.87	1.61	.96	.74	.42	.42	.....
1948	4.81	3.47	3.44	2.63	2.42	1.56	.93	.55	.47	.27	.27
1949	2.91	1.77	1.68	1.31	.99	.87	.23	.23	.23	.23	.12
1950	2.04	.90	.87	.57	.39	.14	.....	.....	.....	.....	.....
Total	71.83	47.92	43.69	33.84	27.79	20.65	12.50	7.82	5.85	3.29	1.28
Average	5.13	3.42	3.12	2.42	1.98	1.48	.89	.56	.42	.24	.09

only 516 pounds per acre while on the poor-practice area it was over 15 tons. A large gully developed on the conservation-practice area which resulted in a soil loss of over 16 tons per acre which was slightly more than on the poor-practice area. In 1948, however, this gully had been converted to a grass waterway and the soil losses amounted to slightly more than seven tons for the conservation practice area (watershed 121); over 22 tons for the poor practice area (watershed 106); and only 55 pounds for the mulched area.

The influence of conservation practices is much greater in reducing soil loss than runoff. On conservation practice watersheds runoff has averaged about 62 per cent of that on poor practice areas. Soil loss has averaged only 42 per cent.

Correlation of Soil Loss With Rainfall Intensities

Although in some cases monthly amounts of rainfall show some correlation, the best correlation of soil loss can be made with rainfall intensities. In Figures 1 and 2, data are plotted showing amounts of soil lost by erosion with amounts of rain falling at rates greater than one inch per hour. Data for storms in May and June appear in Figure 1; and for July, August, and September in Figure 2. Both conservation- and poor-practice watersheds are included. For equal amounts of rain falling at intensities greater than one inch per hour, the greater amounts of soil lost in surface runoff occur in the May-June period and lesser amounts in the July-August-September period. For example, for three inches of rain falling at rates over one inch per hour, the May-June curve (Figure 1) shows five tons of erosion per acre for the conservation-practice watershed and about 18 tons per acre for the poor-practice watershed. For the same rainfall in the July, August and September period (Figure 2) the erosion was 1.5 tons per acre for conservation practices and 8.4 tons per acre for the poor practices. There is a striking difference in the curves representing the conservation practice watersheds as compared with those of the poor practice areas. There is considerably less erosion on the conservation practice areas per unit amount of rain falling at rates greater than one inch per hour. These relationships were developed from data obtained on watersheds having land slopes ranging from 11 to 16 per cent. Insufficient data have been obtained from watersheds of different slope to reveal the effect of land slope.

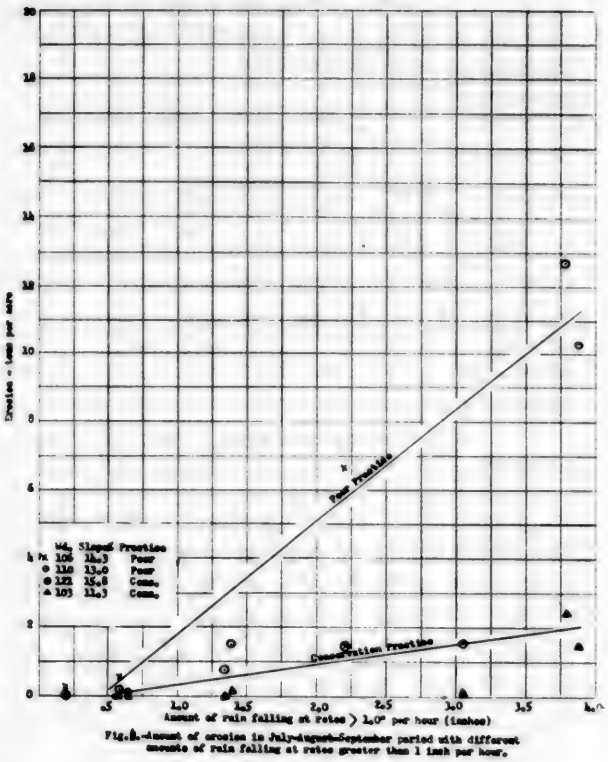


Fig. 2.—Amount of erosion in July-August-September period with different amounts of rain falling at rates greater than 1 inch per hour.

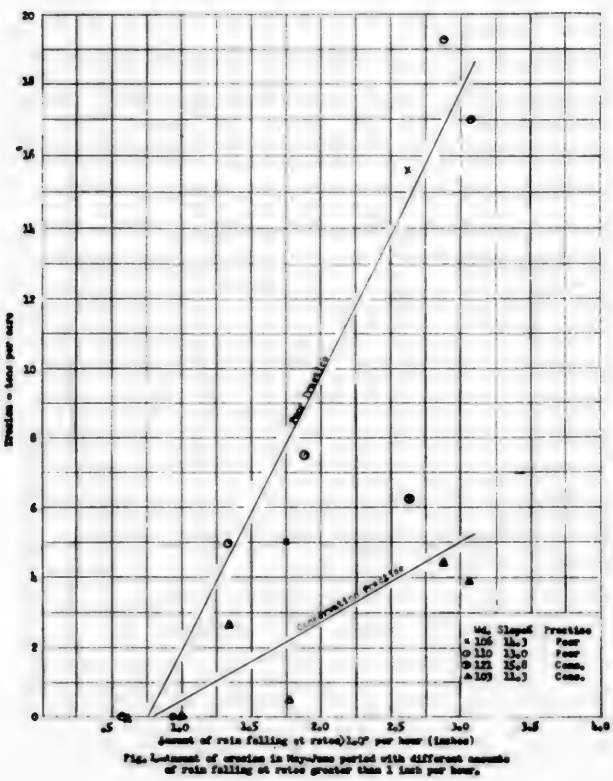


Fig. 1.—Amount of erosion in May-June period with different amounts of rain falling at rates greater than 1 inch per hour.

In classifying precipitation as to amounts, intensities, and the number of storms of various magnitudes occur-

(Continued on page 127)

Land Charateristics and Land Use in the South Tihama—Saudi Arabia

HOWARD J. FERRIS

Usually one envisions the country of Saudi Arabia as being a vast expanse of hot, sterile, sandy desert. While this description may adequately describe the greater portion of the country, nothing could be farther from actuality when speaking of the South Tihama, that part of the Asir province lying adjacent to the Red Sea in the southwestern part of Saudi Arabia. Here one finds verdant fields that have been cultivated for thousands of years, vast areas of grazing land supporting livestock of good quality, and above all a pleasant, energetic people, very much interested in improving their way of life through better utilization of the soil and water resources.

THE SOUTH TIHAMA is part of the extensive coastal plain that characterizes much of the southwestern coast of the country, It extends from the Yemen border on the south to a large volcanic extrusion on the north, a distance of aproximately 120 miles. In width it varies from eight to 25 miles, being bordered on the West by the Red Sea, while the Asir mountains, rising to heights of 8000 feet, forms the Eastern barrier. Jizan, located on the Red Sea, is the principal city and seaport of the South Tihama. It has a population of 25,000 inhabitants, and is the seat of government for the region. Transportation and travel are carried out principally by means of camels and donkeys.

The people of the region are largely of two types, the true Arab, a descendant of tribal stock, and the negro, a migrant from Africa. Aside from small numbers of nomadic Bedouins, the major part of the population leads an agrarian life. However, no one actually lives on the land, but in small villages, moving to the fields in the morning and returning at night.

Climatically the region may be characterized as having a high annual mean temperature, a comparatively small diurnal range, high humidity throughout the year, and irregular scanty rainfall. Average annual rainfall has been estimated from four to eight inches, with amounts up to 20 inches falling in the higher mountains. Most of the rains fall during the winter months from November to February, with a period of monsoon rains occurring during late July and early August. Summers are long and hot, with temperatures reaching 115 degrees Fahrenheit. No frosts occur during the entire year.

Howard J. Ferris is a Soil Scientist with the Foreign Activities Office, Bureau of Reclamation, United States Department of the Interior. He recently returned from a six months assignment as Soil Scientist with the Food and Agriculture Organization of the United Nations mission to Saudi Arabia. The mission was concerned primarily with investigating the irrigation potential of several sites in the country.

Wadi Toasher, the efficient use of the water resources of the wadis, is the key to the future agricultural development of the South Tihama.

Physiographically the South Tihama may be divided into four major land forms, each possessing distinctive physical and cultural characteristics. Lying adjacent to the Red Sea is the Sabkha,[1] a flat, barren, saline belt, varying in width from narrow insignificant bands to areas extending up to 2½ miles inland. Vegetation in most places is very sparse, with Suaeda fruticosa, a very salt tolerant species being the dominant type. Due to the high salinity of the soils, the Sabkha has never been utilized agriculturally.

Occupying a position between the lower lying Sabkha and the mountains is the Khabt[1] or alluvial—aeolian plains, the most extensive land type in the South Tihama. Topography for the most part is level to very gently undulating, with a micro-relief varying from scattered sand hummocks to areas of dunes. Vegetation consists of a variety of drought resistant grasses, shrubs and trees. The soils are formed largely from alluvium washed from the Asir mountains, together with some wind blown material, and are weakly developed and light textured.

[1]Arabic term.

Natives building a dam. Durra field in the background.

Numerous Wadis[2] arise from the Asir watershed and cut through the plains. During periods of rainfall in the mountains, flood waters move down the channels. The majority of the Wadis tend to spread out after striking the plain, and through flood plain conditions and diversion of water for irrigation, large quantities of fine textured alluvium, principally silt, is deposited. The width and depth of deposition varies with the size of the watershed and the amount of runoff. Wadi Baish, the largest in the South Tihama, spreads out to widths of six to eight miles. Topography for the most part is level, with the majority of the land being under cultivation. The soils of the Wadis are immature, stratified, and largely of medium texture. Aside from minor local areas they are free from toxic amounts of salts, and are excellent agricultural soils.

To the East the Asir mountains rise abruptly above the plains. They are composed of a complexity of igneous and metamorphic rocks. In some sectors, notably in the northern part of the region, extensive areas of rocky alluvium has been deposited in the form of fans at the base of the mountains.

Agriculture has been practiced in the South Tihama for two thousand years or more. Two systems of cropping have been in common use—flood cultivation or irrigation, and rain or dryland cultivation. The former is the more universal system used, and is confined to Wadis having sufficient land area and runoff for good crop production.

The method of flooding is a community undertaking. A series of earth filled wing dams (Aqums) are built into the Wadi channel, causing the diversion of part of the flood waters (Sayl) into selected fields. After sufficient water has been diverted to cause a reduced flow, an earth dam, built across the entire channel, downstream from the wing dams, impounds and diverts the remaining flow. Following a flood, the people in the community decide by vote whether sufficient water has been diverted for a successful crop. If the majority vote is in the affirmative, they petition the Amir of Jizan (ruler of South Tihama) for permission to cut the main dam. A section from the middle of the structure is removed and succeeding flood waters are utilized in a similar manner downstream. Priority of water rights varies with the location of the community along the Wadi, with communities upstream having priority over those lying downstream.

The fields usually consist of small rectangular plots, possibly 80 by 100 feet or larger, which are diked to impound the flood waters. After flooding, the water remains trapped until it soaks into the soil, at which time the fields are ploughed by oxen and planted. The principal crop grown under flood cultivation is durra (Sorghum durra). Vast acreages of this crop are found in all of the major Wadis. Durra matures about three months after planting, at which time the stalk is cut by hand a few inches above the ground. The plant often attains a height of 15 feet. It is common to have two or three crops from the original planting providing the moisture supply is sufficient. Yields vary from 35 to 100 saa's par maad (about 40 to 110 bushels per acre) depending on the character of the soil and the moisture supply. Most of the grain is used locally by the natives for food, with stalks being fed to livestock. Some sesame is grown, and small plots of okra, radishes, turnips, and watermelons may be found. No crop rotations are used, the custom being to raise durra year after year on the same field, providing water is available. The periodic deposition of silt after each flood is the only soil fertility measure used.

Rain or dryland cultivation is confined largely to the Khabt or Plains area between the Wadis. Dukn (*Pen-*

(*Continued on page* 124)

Fields in Wadi Kulab Planted to durra sorghum.

[2]Arabic term for stream bed—includes both channel and adjoining valley.

Oklahomans Learn on the Land

EDD ROBERTS AND DAVID E. RYKER

Land judging, as conducted here in Oklahoma, is a new type of conservation contest based on a simple axiom that "Experience is the best teacher." The Extension Service and Boards of Supervisors of the Soil Conservation Districts in Oklahoma have sponsored these land appreciation schools and land judging contests as one means of educational work in their programs.

THE PURPOSE OF THESE LAND judging or land appreciation schools and contests is to teach people how to put each piece of land to the use for which it is best suited and to treat it according to its needs for controlling erosion, and improving soil fertility. It is a way of informing and training people of the practices and treatments necessary for developing and maintaining a permanent agriculture.

The actual contest was designed to glamorize, so far as the general public was concerned, a dry subject. For years we have been talking with farm people about the conservation and improvement of their soils and in most cases they agreed that it was important, yet they did not always understand the terminology used in explaining the diffeernt classes, capabilities and practices necessary to get desired results. They did not always understand because they could not associate the actual condition of the land to the lecture. It is hard to tell people what Class III land is or explain the difference in texture or permeability and realizing this, we began in 1941 a method of teaching conservation that has spread to many other states with some variation.

The first school was held in 1941 at the Red Plains Conservation station, Guthrie, Oklahoma, for 4-H club boys. Harley Daniel, project supervisor, and myself believed then as we do now that a method could be developed for judging land along the same lines that livestock judging contests were held. Four fields were selected with different classes and capabilities. The morning was given to instructions and in the afternoon, 25 4-H club boys went into the fields where certain facts were pointed out to them, based on recent research information. The boys then placed the fields in one, two, three, four order and marked in their score cards reasons why one field was better than the other. This was a meager beginning and the instructions and score cards were far from being perfect, but we were determined to make a competitive contest with glamor and interest enough to keep these boys and others coming back to learn more about the soil and how to care for it.

A few years later the contest was opened to FFA members and in April, 1946 was taken to the field on a mass production basis at Pauls Valley, Oklahoma. Garvin county agent, Alton Perry, and Sam Lowe, district conservationist, Soil Conservation Service, and his associates with our help set up a contest for adults and youth and more than 500 people participated.

After each contest we could see the need for revisions in the score cards and in the methods of instructions and actual field explanations. To date the score card has been revised 27 times. These revisions have been made through the complete cooperation of all agencies and the terminology used is the standard developed by the Soil Conservation Service. So down through the years, the land judging schools are no one person's idea, but the credit for their development lies with many people in the various agricultural agencies.

Contests have been held in 70 of the 77 counties of

County agent serving as official at the Land Appreciation training school and Land Judging contest at the Red Plains Conservation and Experiment Station in the fall of 1951.

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4-H club members participating in a land appreciation training school and land judging contest at the annual 4-H Round-Up at the experiment farm, A and M College, Stillwater, Oklahoma.

Oklahoma. A total of 184 schools have been conducted with an attendance exceeding 37,000.

Today, when a school is set up, the county agent gets with other agricultural agencies in the county and discusses plans. Four fields are selected, in one vicinity to conserve travel and time, and soil conservation technicians make the actual placings of the soil and land. A school is held the day before the contest for the agricultural leaders who are going to help with the contest. They are assigned specific jobs and instructed in their duties and with all this preliminary work out of the way and each man knowing what he is doing, the contest can be run off smoothly and follow a timetable schedule.

On the day of the contest, after registration, the group is instructed in filling out the score card and different terminology is explained. Participants judge both as individuals and/or as teams of three members and an alternate.

These people are given land judging cards which have been designed to eliminate as much confusion as possible. They do not have to write in anything, merely place a check in the square which they think most nearly fits the condition of the soil which they are judging. First they check the surface texture. This has been divided into coarse, medium and fine. Then there are checks for subsoil permeability and depths of surface soil and subsoil and another on which they check the slope of the land. These fields, of course, have been gone over by the county agent and the Soil Conservation Service soil technicians and placed, usually the day before the meeting as explained above.

There is also a place to check the amount of wind and water erosion; whether drainage is good or poor and then class the land from one through eight. At the bottom of the card is a place for recommended treatments and a card is supplied for each field that they judge.

To get the recommended treatments they are told that there are a certain number of practices, which agricultural leaders feel is necessary to put the field into its best productivity. They are then given a sheet on which a number of recommended practices are listed, which if certain ones are applied to the field it could be brought back into or its productivity increased. They take a number from it from the recommended practice and place it in a square at the bottom of their judging card and hand it in for grading. With the individual checking part of his score it is possible to grade cards of several hundred people in a few minutes. Fifty points is a perfect score on any one field. This is 25 points for correct identification of the situation and 25 points for recommended practices. These scores are small and thus eliminate the chance of error in grading.

This grading and scoring to eliminate ties and pick a winner was one of the biggest headaches facing us in the contests. We finally went to a mathematician for help. We applied what is called "Permutation and Combinations" and set up a system of tie breakers so that

now it is easy to have one winner with as many as five or six hundred people participating.

In the beginning of the contests and schools we believed that the people were confused with too much information at one time about soils. Today that has changed. We realize that land is treated according to its limitations and hazards and we explain as thoroughly as possible what these are on the particular field under observation. We endeavor to show the farmer where he needs to give attention to the field to bring it up in production and to keep the land from further depletion. The Extension Service, Soil Conservation Service employees and other agriculturists encourage the acceptance of soil conservation and improvement as a way of farming.

Young farmers are taught a technique in livestock or dairy judging that they use throughout their life, likewise, in land appreciation, they are taught a technique that they will be able to apply anytime they step onto a pieçe of land. The physical characteristics of the land are well-known by soil scientists. The farmer should learn them because he is the one who will actually do the soil conserving and improvement job.

We know that soils have traits the same as livestock and crops; that it is possible to check certain clues which tell us much about the land. Some features of soil are permanently fixed. In such a case the limitations must be recognized and lived with as it is. In this case it is a matter of changing the use to its most adaptable purpose. Perhaps the greatest advantage of these land judging schools is that we have been able to help put the finger on the major strong and weak points of the land, and farmers, both young and old, recognizing these points are able to put the land to use in accordance with better conservation and improvement practices.

The fundamentals taught in the contest are the kind young farmers as well as old, can apply to land they now operate or may operate in the future. Although we cannot make a soil scientist out of people through these schools we do believe that the training received in this program cannot help but bring about a greater appreciation of the land and its welfare.

This program was discussed over NBC's Farm and Home Hour in December, 1949. Requests have come into the Extension Conservationists office from 35 of the states and six foreign countries. Representatives from three of the six countries have visited with the Extension Conservationist about establishing such a program in their countries.

LAND JUDGING PLACING CARD — No. 1

1. (Name or No.) _____
2. (Address) _____
3. _____
4. Indicate your answer by an X in the square.

Part No. 1

Score Part 1
Score Part 2
TOTAL SCORE

Field No.	Surface Texture	Subsoil Permeability	Depth of Surface Soil and Subsoil	Slope
	☐ Coarse ☐ Medium ☐ Fine	☐ Very Slowly Permeable ☐ Slowly Permeable ☐ Permeable ☐ Freely Permeable	☐ Deep ☐ Shallow ☐ Very Shallow	☐ Nearly level ☐ Gently Sloping ☐ Moderately Sloping ☐ Strongly Sloping ☐ Steep ☐ Very steep

	EROSION		Drainage	Land Capability Class No.
	Wind	Water		
	☐ None ☐ Slight ☐ Moderate ☐ Severe ☐ Very Severe	☐ None ☐ Slight ☐ Moderate ☐ Severe ☐ Very Severe	☐ Poor ☐ Good	I II III IV V VI VII VIII

Field No.	RECOMMENDED TREATMENT — Part No. 2
	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Skid-Road Erosion Can Be Reduced

SIDNEY WEITZMAN AND G. R. TRIMBLE, JR.

This can be done, the authors say, by planning an efficient road lay-out that avoids steep gradients, and by installing simple water bars to keep the road drained. These recommendations are based on studies of an experimental logging job in West Virginia, where four different kinds of skid road were tested.

IN THE RUGGED APPALACHIAN Mountains, the forests occupy the steeper slopes. When forests on these steep slopes are logged, there is always some danger that erosion will develop on the skid roads.

The customary logging practice in many parts of the Appalachian region is to to run skid roads straight up and down hill. Some erosion always results (Figure 1). Often it is serious. Some skid roads used 40 or 50 years ago can be identified today by the erosion that followed.

Erosion not only increases the costs of logging by making former skid roads unusable; it also damages the watershed values of the region. Although no one knows exactly what effect skid-road erosion has on flood waters, it is no doubt great. Scoured stream beds are evidence that eroding skid roads permit water to run off rapidly. Siltation also results, polluting water downstream. Muddy waters are always in evidence after a typical logging operation.

At the same time, water that is able to run off rapidly on eroding skid roads has no chance to be absorbed into the soil and stored for future use, as it normally would be. This damages the watershed's ability to maintain a reliable flow during low-water periods.

Lumbering will continue to be an important industry in this region. Skid roads will continue to erode. But can't this erosion be reduced?

A Study of Skid Roads on Fernow Forest

A study of skid-road erosion was made on the Fernow Experimental Forest near Parsons, West Virginia, where the U. S. Forest Service is carrying out research in both timber management and watershed management. Four 5-acre areas were used (Figure 2).

Four different intensities of cutting—high order, good, fair, and poor—were being tested on these areas. At the same time, four different qualities of skid roads, considered appropriate for the different cutting practices, were tested. The specifications for these skid roads were as follows:

Sidney Weitzman and G. R. Trimble, Jr., are research foresters at the Mountain State Research Center, Elkins, West Virginia, one of the field units of the Northeastern Forest Experiment Station, U. S. Forest Service. They are carrying out part of a research program that is aimed to integrate forest management and watershed management.

Figure 1. Erosion on logging roads is a serious problem in mountainous areas. *Left:* This skid road, running straight down hill, washes and gullies with every rain; it will be unusable for the next timber harvest. *Right:* A typical West Virginia skid road immediately after a rain. Poorly located and poorly drained, this skid road is becoming a stream channel.

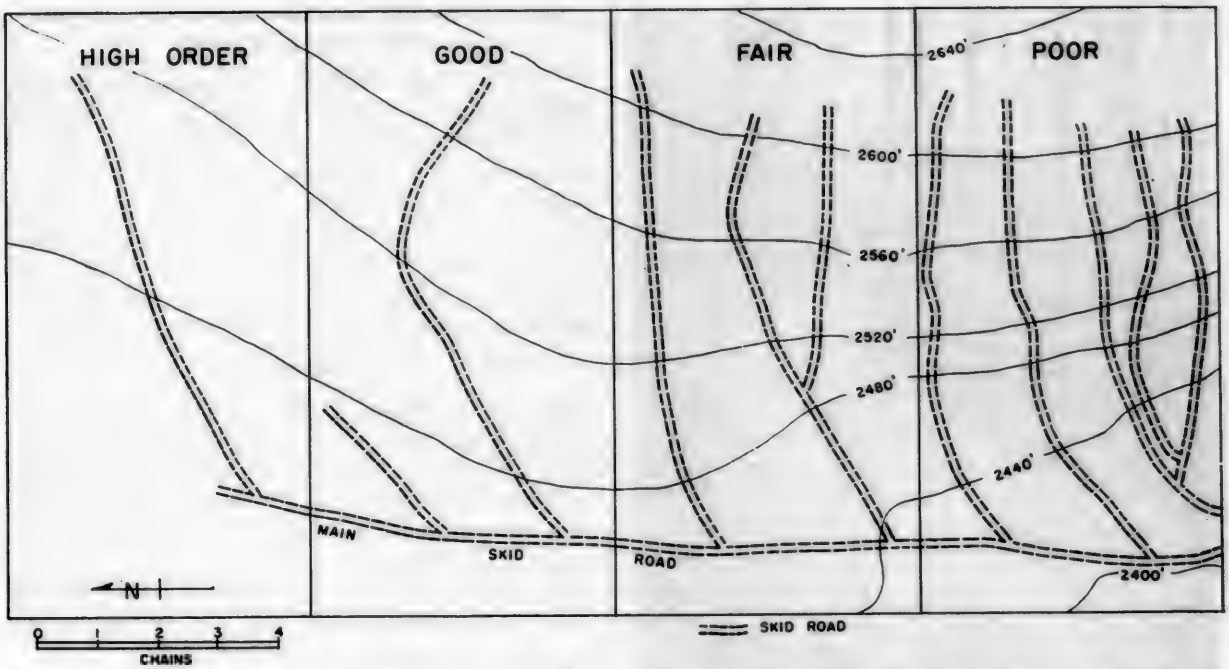


Figure 2. The skid-road-erosion study areas on Fernow Experimental Forest. The labels "high order," "good," "fair," and "poor" indicate both the cutting-practice level used and the quality of the skid road. Note the greater mileage of skid road in the "poor" area, where the cutting was heaviest.

High order.—Skid roads are not to exceed a ten-per cent slope except for short distances (Figure 3). At the end of the logging operation, water bars are to be installed wherever needed to divert water off the skid road.

Good.—Skid roads are not to exceed a 20-per cent slope except for short distances. At the end of the logging operation, water bars are to be installed at approximately 2-chain intervals.

Fair.—No restrictions on skid-road location. At the end of the logging operation, water bars are to be installed, but not closer than two chains. (On this area the skid roads ran straight up and down hill with an average grade of 28 per cent.)

Poor.—No restrictions on skid-road location. No water bars or other treatment are to be used. (On this area the skid roads ran straight up and down hill with an average grade of 34 per cent.)

The study area is located on a limestone bench at 2,500 feet elevation. The topography is varied. The soil is relatively free of rocks. The climate is characteristic of the high country west of the Allegheny Front in West Virginia. Mean temperature is between 45° F and 50° F. Annual mean precipitation is between 50 and 55 inches; it is well distributed throughout the year. In land use, the history of the area includes, in brief, clear-cutting, burning, and finally Federal acquisition and protection. The predominant forest type is a mixture of cove hardwoods and northern hardwoods.

These test areas were logged during the winter of 1949-50. The trees were skidded by tractor over skid roads constructed according to the standards outlined above. Immediately after logging, water bars were installed as prescribed.

To measure the amount of erosion, study sections were established at 2-chain intervals. Cross sections were plotted and recorded. One year later, the amount of soil that had eroded away was measured at each study section. No effort was made to determine the movement of the soil after it left the skid road.

Results

Although this preliminary study was rather limited in scope, the results (Table 1) showed considerable differences in erosion from the four kinds of skid roads used.

Since the four areas differed so much in topography that direct comparisons between the areas were impossible, the amount of erosion was computed on the basis of grade and distance between water bars. An alinement chart was constructed to show erosion by combination of grade and distance, and the erosion for each kind of skid road was read from the alinement chart.

Figure 3. A high-order skid road. Constructed on a low gradient and protected by water bars, this road serves its area efficiently and economically. It will be usable for the next logging operation and could be converted into a permanent truck road.

The mileage of skid road required in logging the different test areas doubtlessly affected the results considerably. (The lower levels of cutting practice called for removal of more trees, and more skid road was needed.)

Table 1.—Erosion on skid roads during first year after logging operation

Quality of skid road	Length of skid road per 5-acre plot	Erosion per 100 feet of skid road	Total soil moved per 5-acre plot
	Feet	*Cubic feet*	*Cubic feet*
High order	530	52	275
Good	790	65	515
Fair	1,390	70	975
Poor	2,380	91	2,165

Discussion

Although the results of this preliminary study can be considered only tentative, they indicate that erosion on skid roads can be controlled by limiting the gradient and installing water bars. Observations indicate that, where practical, seeding to stablish new ground cover might also be helpful.

The mileage of skid roads required can be reduced greatly by careful planning. The less mileage needed, the less the erosion and the less the cost.

Moreover, careful planning of skid roads may pay off as a long-term investment. A skid road properly located and well maintained will not wash out, and can be used for future logging operations. And, as the standards of forest management are improved, a simple skid road that was properly located may later be converted into a high-standard truck road at a considerable saving in cost.

Land Use on South Tihama

(*Continued from page* 118)

nisetum spicatum) a millet, is the principal crop raised here. It is particularly adaptable to sandy soils, and when sufficient rains occur is planted rather extensively. The most common method of planting consists of making a hole in the ground with a pointed stick, inserting a handful of seed and tamping the hole with the foot. Occasionally the area selected for planting is cleared of vegetation and shallow furrows are scratched in the surface soil. Normally, however, the plantings occur among the native vegetation. Depending upon the amount of rainfall, the crop may produce 15 saa's per maad (about 16 bushels per acre). It is utilized in a similar manner to durra.

Aside from the planting of dukn, the Khabt is used largely for grazing. Excellent herds of camels, goats, Brahama cattle, and flocks of fat-tailed sheep roam over the plains.

Associated with the type of land use in the South Tihama are several problems, the major one being that of the relatively uncontrolled used of water. Particularly after a period of heavy rainfall in the mountains, flood waters move down the Wadis with great force, inundating and damaging crops, forming large gullies, washing out dams, and at times causing the destruction of villages with a loss of human life. During subsequent dry periods no water is available for crops. One of the solutions to the problem appears to be the construction of storage facilities on the upper sections of the Wadis to impound flood waters, together with a diversion system that will facilitate the controlled use of water. This would permit the raising of a wide variety of climatically adapted crops and the use of rotations. The disadvantage of this system from the native point of view is that the renewed soil fertility created by silt deposition would be lost. The use of fertilizers, however, would offset this. Siltation of reservoirs would also have to be contended with.

Despite the problems involved, the South Tihama has excellent soil and water resource possibilities, and should be capable of a substantial agricultural development in the future.

Walkways Improve Grazing Distribution

ROBERT E. WILLIAMS

IN THE COASTAL MARSHES of Southern Louisiana are areas of natural pasture or range that produce an abundance of nutritious grasses for livestock production. Productive as these areas are, however, the livestock industry there is beset by hazards and vexations that seem at times to counterbalance, if not outweigh altogether, the advantages and opportunities.

All told, there are nearly two million acres of these grazing lands in Cameron, Vermillion, Iberia, St. Marys, Lafourche, Terrebonne, Plaquemines, St. Bernard, Jefferson and the lower Florida parishes.

These areas have been used for the grazing of domestic livestock since the first hardy settlers built homes along the low coastal ridges or cheniers. The obstacles to successful livestock production have served, it appears, to develop through natural selection as much as through planned improvement a strain of cattle that endure heat, withstand insects and when necessary graze belly deep in deep water periods.

Wildlife values here vary greatly, but generally these ranges are slightly higher in elevation and consequently are less productive of wildlife than are the areas of deeper marsh which are seldom used by livestock.

In addition to heat, insect and disease, the livestock producer must expect storms, heavy rainfall, and wind tides which submerge grazing areas and render water supplies unfit for livestock.

And then there is the problem of poor grazing distribution. This is a problem which it is possible, and profitable, for the livestock producer to do something about.

To a large extent, grazing use of the range area depends on the number and distribution of the low coastal ridges. These ridges vary in elevation from a few inches to a few feet above the general ground level, but they serve as a place for cattle to rest, leave young calves while grazing, and give some relief from mosquitoes. Too, the ridges are the only places where cattle can be fed and looked after during emergency periods.

As a result, ridges and adjacent areas are usually severely overused while range a little more distant is about properly used, and the more remote areas are actually used too little, if at all. During wet periods, the ridges are practically denuded by the concentrations of cattle, and this condition may exist even when the range unit as a whole is about properly stocked.

There are two general range sites in this area, fresh-marsh range and salt-marsh range. Fresh-marsh range is characterized by vegetation which grows only under practically fresh-water conditions. The salt-marsh site covers the broad band extending from fresh-water conditions to salinities equal to that of sea water. There is considerable mixing of certain plants under these broad site delineations, but the true nature of the site can be readily recognized by the presence of key plants.

On the fresh-marsh site, paille fine (*Panicum hamitomon*) and giant-cutgrass (*Zizaniopsis miliacea*) are the most valuable forage plants. These two grasses decrease under overgrazing, and are green all twelve months of the year when winters are mild. Paille fine is killed above the ground by frost, but giant-cutgrass, not so vulnerable to freezing, furnishes good winter grazing almost every year. Giant-cutgrass is an excellent indicator of firm soil conditions, but paille fine grows under soil conditions varying from firm mineral clays to "floating" organic marsh.

Fresh-marsh range in excellent condition will furnish four cow months grazing per acre. (Table 1.)

Table 1. Approximate safe stocking rates on marsh range sites.

Range Condition	Acres Per Cow Yearlong		Percent Climax Vegetation
	Fresh Marsh	Salt Marsh	
Excellent	3	4	75 - 100
Good	4	6	50 - 75
Fair	6	8	25 - 50
Poor	10	12	0 - 25

Salt-marsh forage grasses of highest value are marsh-hay cordgrass (*Spartina patens*), big cordgrass (*Spartina cynosuroides*), smooth cordgrass (*Spartina alterniflora*), seashore paspalum (*Paspalum vaginatum*), and seashore saltgrass (*Distichlis spicata*). Salt marsh range is only a little less productive than fresh marsh range, (Table 1.), and is most valuable for winter grazing. Many stockmen use it for a six-month grazing season beginning October 15 and ending April 15. Higher ranges along the ridges are reserved for summer use. In a few cases cattle are trailed to the forest range about sixty miles north for the spring and summer months.

Longtom (*Paspalum lividum*) is a valuable native grass used for summer pasture and hay. This grass grows along the ridge flanks and may extend from strictly fresh sites into slightly salty areas.

Hairypod cowpea (*Vigna repens*) is the most common legume in the marsh. This plant, an annual, is found under a wide variety of conditions on both marsh

Robert E. Williams is a zone conservationist with the Soil Conservation Service. He is located at Crowley, Louisiana.

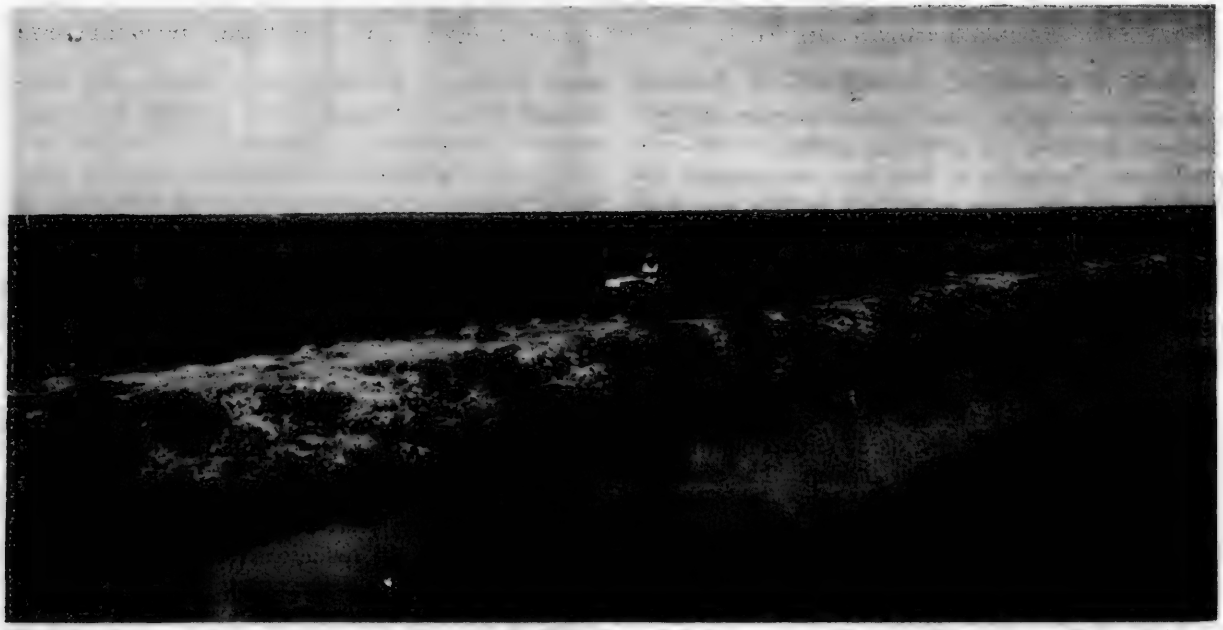


Photo 2.—A new walkway adjoining a highway in the Gulf Coast Soil Conservation District of Louisiana. Owner Johnnie Meaux smooths the surface with a dragging beam. Water filled borrow pits at the side keep cattle off the highway.

sites. Because it is an annual, it is not very dependable for grazing; but in favorable seasons, it makes a large volume of forage.

To relieve the grazing distribution problem, a few stockmen, with assistance of local Soil Conservation Districts and Soil Conservation Service technicians, have been building levees for cattle trails into the range areas from the ridges. These levees or "walkways" improve grazing distribution because they serve as trails, bedgrounds, and a place for cows to leave young calves while the mothers are grazing. And they permit easier working of cattle.

Borrow pits from which earth is taken to build the walkway are staggered from side to side of the levee at intervals of several hundred feet. (Fig 1.) This permits the cattle to move off the levee in either direction to graze and also prevents the flow of water into pits. When the walkways are built along a range boundary, the earth is all taken from one side of the walkway, but plugs of earth are left in the pits at intervals to prevent the flow of water. Openings or bridges are provided whenever the walkway crosses natural drainages. By staggering pits, leaving plugs, and installing bridges, interference with natural water conditions is kept to a minimum and natural growing conditions are not changed.

To serve the purpose for which they are intended, walkways are being made two feet high (settled) and with a ten-foot top width. They are usually connected to ridges or existing levees. Since most stockmen in the area say that cows will graze about a quarter of a mile from a ridge or levee when water is on the marsh, walkways are spaced one-half mile apart.

Walkways were constructed in the summer of 1950 by Mayo Boudreaux, a veteran cattleman of Creole, Louisiana, in Cameron Parish. He had assistance in working out a range conservation plan from the Gulf

Table 2. Analysis of Several Marsh Range Forage Plants[1]

Plant	Growth Stage	% Crude Protein	% P	% Ca
Giant-cutgrass	young	15.50	.18	.58
Zizaniopsis miliacea	bloom	13.94	.17	.75
	mature	12.00	.16	.78
	dormant	6.00	.08	.48
Paille fine	young	18.31	.21	.19
Panicum hemitomon	bloom	16.75	.19	.60
	mature	.....	...	....
	dormant	9.42	.08	.18
Big cordgrass	young	12.33	.22	.18
Spartina cynosuroides	bloom	6.16	.15	.49
	mature	6.56	.12	.60
	dormant	5.19	.09	.27
Marshhay cordgrass	young	12.74	.17	.17
Spartina patens	bloom	7.50	.10	.22
	mature	5.42	.10	.26
	dormant	.....	....	....
Smooth cordgrass	young	11.09	.20	.35
Spartina alterniflora	bloom	7.81	.17	.53
	mature	9.50	.17	.74
	dormant	.....	....	....

[1] Analyses were made by Regional Operations Laboratory, Soil Conservation Service, Fort Worth, Texas. Samples were collected monthly during 1950.

Coast Soil Conservation District, and technical help was furnished by the Soil Conservation Service. The only answer to solve the problem of overused ridges and underused flats was to build levees on which cattle could move over the range regardless of water conditions. Boudreaux completed one and three quarters miles of walkways in the summer of 1950. After wintering about 350 head of cattle on this range, he reported a death loss of less than one per cent. Losses up to twelve per cent were suffered on many ranges during the same months.

Convinced of the value of the practice, Boudreaux built another quarter mile of walkway in the summer of 1951 on a different range unit, and a half dozen more stockmen built walkways on their ranges during the past summer months. One operator in Lafourche Parish constructed a walkway 3,600 feet long connecting two ridges across a paille fine "prairie."

In nearly every case of marsh-range planning, technicians are running into a severe distribution problem. Stockmen can readily see the value of walkways in their operations. Many are planning to build walkways when draglines may be engaged.

One soil conservation district dragline operating for $7.50 an hour has been constructing walkways for around $1,300 per mile, but costs generally are expected to average a little higher. The machines must move on mats because of wet soil conditions.

Along with the use of walkways, it is very important that stockmen regulate grazing as to numbers of cattle and season of use in order to protect the plant varieties he wants to increase. Aware of grass values, most producers are eager to favor the better grasses through the use of good management practices. They realize that many of these marsh forage plants are equal in nutritional value to seeded and fertilized pasture species.

Small Agricultural Watersheds

(*Continued from page* 116)

ring at various times of the year, some idea is obtained regarding when and how often various storms may be expected to occur. The relatively low intensities occurring at certain times of the year introduces situations and problems that are entirely different than those occurring in June and July when intensities are higher. Information on soil conditions, vegetal cover, and other factors is needed to present a complete picture because a knowledge of rainfall characteristics in itself is not the sole criterion of runoff and soil loss problems. The recognition of its place in agricultural hydrology will aid in the solution of these problems.

A study of some relationships of preciptation and soil loss on small two-acre watersheds was made in an area representing the North Appalachian Region.

There appears to be little correlation of annual and monthly preciptation with soil erosion. A direct correlation was revealed when amounts of rain falling at the higher intensities were compared to amounts of erosion.

Individual storms of one inch or more rainfall were more numerous in the months of May, June, and July followed by March and August. The monthly amounts of rain falling at high rates were shown to be the greatest in June and July followed by May, August and September. In the other seven months no large amounts of rain fell at the higher intensities.

Soil conservation practices reduced soil loss to a considerable extent as shown by data obtained from paired small two-acre watersheds for the period 1941-1950. There appears to be a correlation of soil lost in surface runoff with amounts of rain falling at rates greater than one inch per hour. The relationship for the May-June period appears to be noticeably different from that of the July-September period. More data are needed to evaluate the effect of different land slopes on watershed soil erosion.

The Scientist (he needs very little science but a lot of commonsense) can now provide quite a simple and reliable recipe for soil conservation in almost any part of the world. . . The difficulty is not to determine what measures to apply to conserve soil fertility but how to create the social and economic environment in which the appropriate measures will be applied spontaneously.

Where permanent agriculture is securely established the "problem" of soil conservation virtually does not exist, because it has been solved. Permanent agriculture and soil conservation are almost synonymous.

G. V. JACKS *in "Four Thousand Million Mouths"*

Range Soil Conditions Influence Water Intake

BEN OSBORN

One of the big opportunities for conserving water on range lands of the West is to manage grazing, to develop and maintain favorable cover and soil conditions for storing rain where it falls. This will use the moisture for producing feed for livestock while reducing erosion, flood, and siltation problems resulting from excessive runoff. Some of the potentialities in this phase of the conservation program are suggested in the photographs and examples presented here.

THE CAPACITY OF RANGE LANDS to absorb intensive rains without runoff is profoundly affected by changing soil conditions associated with the relative conditions of the range vegetation.

Cover evaluations conducted cooperatively by the Operations and Research Branches of the Soil Conservation Service on ranges of the Western Gulf Region showed:

1. Deep soils of all textures, when adequately covered with grass and litter and in optimum condition, were capable of absorbing up to 2 inches of rainfall at intensities of up to 50-year frequency.

2. In field tests some examples lost most of the water applied and others on the same soils lost practically none.

Different water intake capacities on the same soil were caused by differences in the cover on the surface and in physical and biological conditions of the soil associated with the cover conditions.

These differences in cover and soil condition within the same site caused greater variation in water lost and held than did the permanent characteristics of the soil, such as texture. Exceptions were very shallow profiles with impervious rock near the surface, where water losses were high regardless of cover or soil conditions.

The field tests consisted of standard applications of 2 inches of water in 20 minutes to series of 12x18 inch plots selected to represent different cover conditions on each of 14 important range sites in Texas and Oklahoma. The water was applied in the form of falling drops of controlled size and velocity by means of a raindrop applicator mounted on a truck. Water and soil leaving the plot either as splash or runoff were collected and measured, indicating the comparative effectiveness of the cover in preventing soil splash and water loss.

One example will illustrated the degree to which structure within the same soil unit may vary with cover conditions in response to past use of the range, and how these conditions affect water intake. A series of three plots on the Rolling Red Plains heavy deep upland site lost 21 per cent, 59 per cent, and 63 per cent respectively of the water applied in the standard test. This site has a medium-textured surface soil underlain at a few inches by a tough clay, and is considered one of the most slowly permeable soils of the problem area. Photographs of core samples from each plot after the splash test amply explain the wide differences in water losses.

The plot which absorbed the most water was in fair condition but had not been grazed for several years and was covered with a dense stand of vine-mesquite grass providing 10,605 pounds of cover per acre. Water loss was 21 per cent, leaving 79 per cent taken in by the plot. The core revealed a porous granular structure which permitted free percolation of the water and which withstood the impact of the drops during the test. This soil contained 5.37 per cent organic matter and its volume-weight was 0.99.

Another plot was in poor condition, in an area that had formerly been cultivated. Although lightly grazed at the time of the test, with 3,520 pounds of cover per acre, it lost 59 per cent of the water applied. The core showed the soil densely compacted to a depth of 1½ inches. It contained only 1.78 per cent organic matter, and had a volume-weight of 1.36.

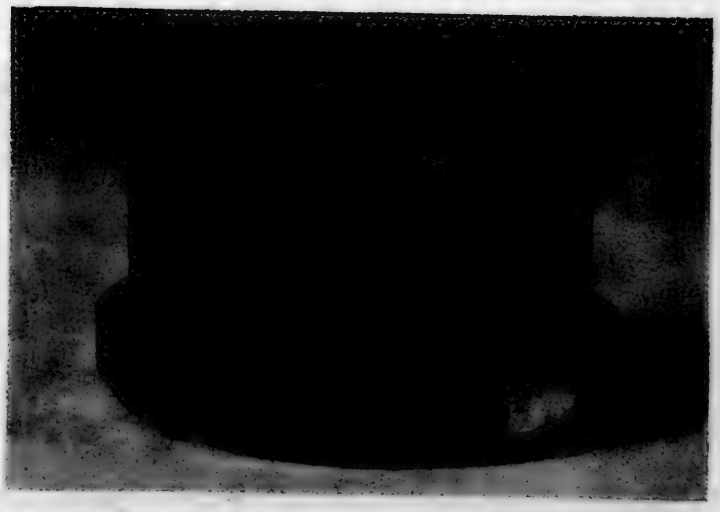
The third plot was in a cultivated field, which had been thoroughly plowed and prepared for planting a few weeks previously. Young winter peas provided 1,082 pounds of cover per acre. This plot lost 63 per cent of the water applied and runoff started in 4 minutes. The photograph of the core shows plainly why this occurred. Although this soil was more porous than the preceding plot when the test began, with a volume-weight of 1.24, the drops striking the surface quickly sealed it over, preventing the entry of water.

The photographs on the following pages show some of the soil surface conditions on range lands which regulate the intake of water during rains. They emphasize the importance of factors not ordinarily considered in soil classifications, but which are related to range conditions identified by the character of the cover.

Ben Osborn is soil conservationist with the Soil Conservation Service at San Angelo, Texas. A more complete report of the water-intake phase of the cover evaluations, of which he was field party chief, has been published in the Journal of Range Management. Detailed results of the soil splash measurements will appear in a forthcoming bulletin to be issued by the Soil Conservation Service.

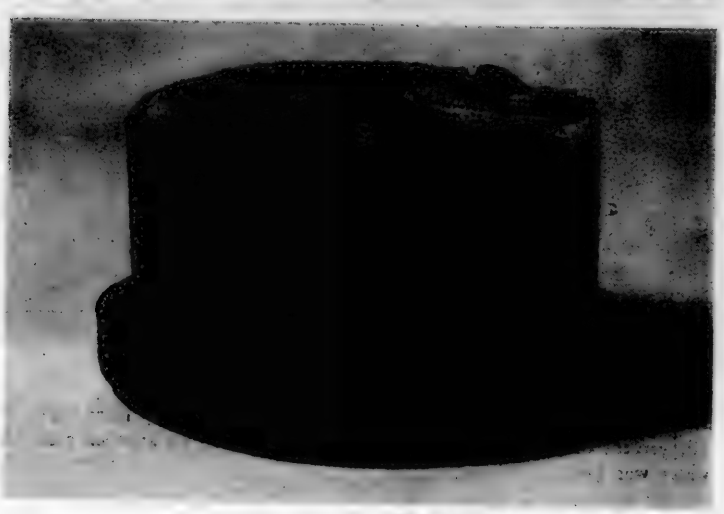
CONDITIONS REPRESENTED

1. Fair condition range with an abundant grass cover resulting from protection.



2. Poor condition range.

3. A cultivated field recently plowed.



Photos by Soil Conservation Service

Different conditions of the same soil under different cover resulted in water losses of 21 per cent, 59 per cent, and 63 per cent, respectively, from top to bottom, when two inches of water was applied with a raindrop applicator to field plots represented by these cores.

Photo by Soil Conservation Service

An algae crust formed on an exposed Cross Timbers sandy loam soil in poor range condition held soil splash to a low level but 68 per cent of the water was lost as runoff. However, on another plot from which the crust was removed, 85 per cent of the water was lost.

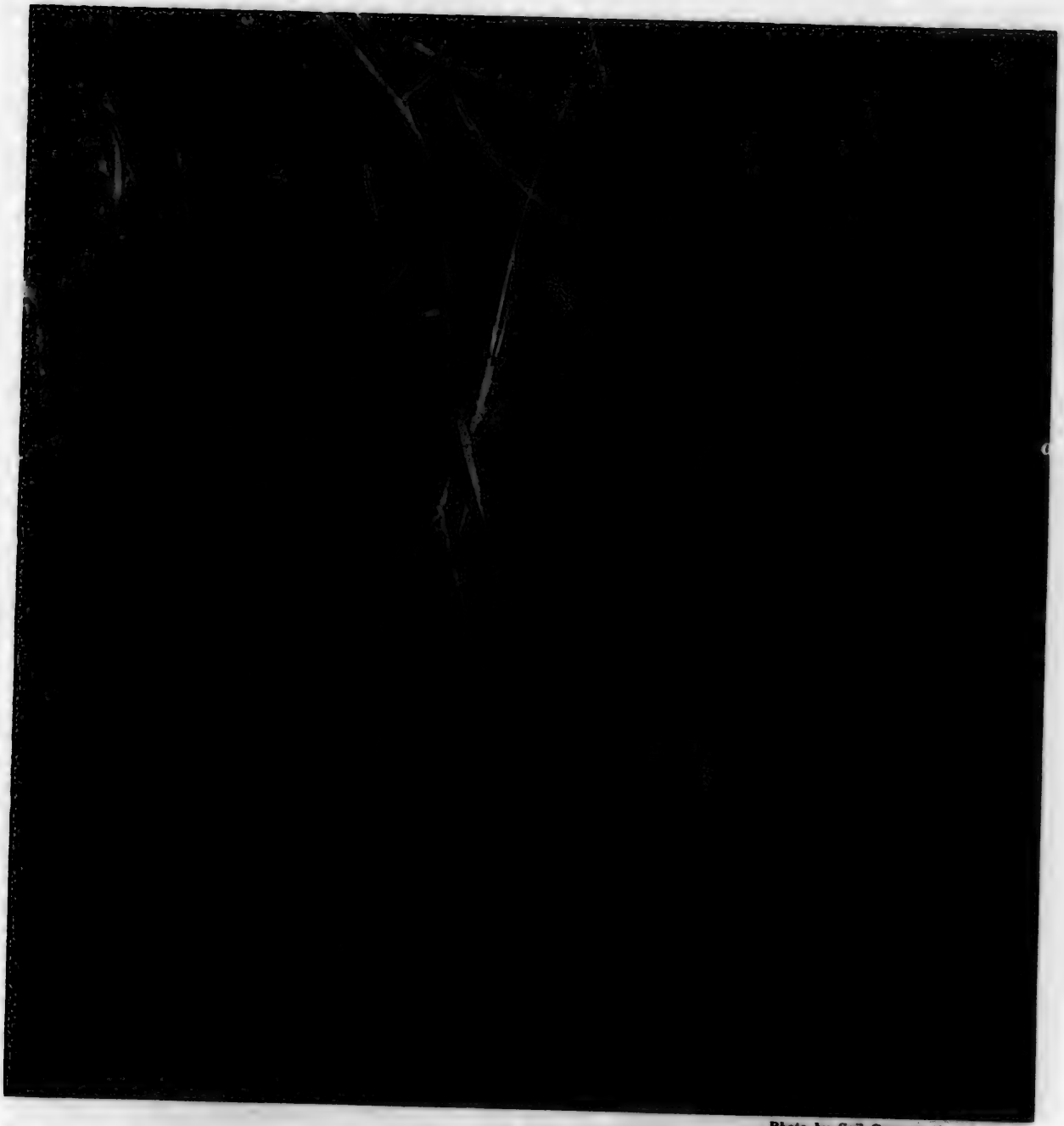


Photo by Soil Conservation Service

With a cover of little bluestem grass and a mulch of grass and leaf litter, another example of the same Cross Timbers sandy loam soil in excellent range condition lost only 25 per cent of the water applied in a field test. This was the minimum water loss for any example of this shallow soil which rested on sandstone at a depth of 18 inches.

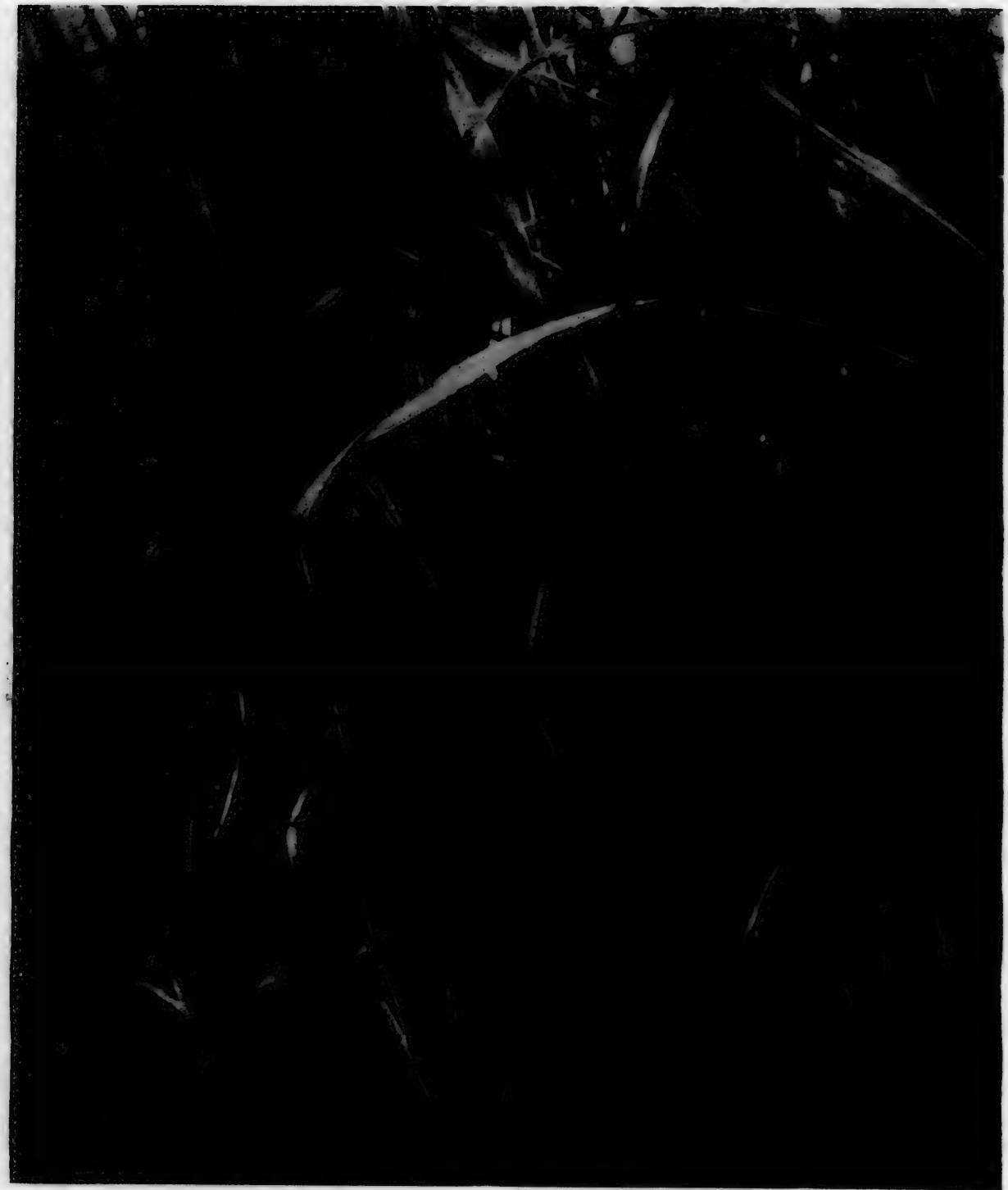


Photo by Soil Conservation Service

A Grand Prairie deep clay loam in excellent range condition with a cover of big bluestem grass and litter held 2.01 inches of water applied in 20 minutes with a raindrop applicator. Immediately after this test, the plot absorbed an additional 35.17 inches of water applied by means of infiltration rings in 1 hour and 50 minutes. A Poor condition plot on the same soil took in only .78 inch in the 20-minute test and lost 61 per cent of the applied amount.

Recent Research Reviews

JAMES H. STALLINGS

The Reviews by J. H. Stallings that follow are a regular feature in the JOURNAL. It is hoped that the projects reviewed from time to time will be helpful to conservationists everywhere. Members of the Society are urged to indicate their interest in the kind of research work that should be reviewed.

A Graphic Method Of Finding The Depth Of Irrigation Water Applied. *By* JAMES E. GARTON; *Okla. Agr. Exp. Sta. Bul. No. B-368. April 1951.*

An easy method of explaining how to compute the depth of irrigation water which has been applied is sometimes needed. This bulletin presents a nomograph developed to meet that need.

What About Liquid Fertilizers? *By* G. W. VOLK, J. H. WILSON *and* J. L. HAYNES; *Ohio Agr. Exp. Sta., Farm and Home Research, Vol. 36, No. 258, pp. 8-9. January-February 1951.*

This article outlines principles of fertilization that have a bearing on the practice of treating seed with liquid fertilizer and describes results of recent tests involving this type of treatment. None of the tests showed any evidence of benefit to crop response either in the form of visible improvement in seedling growth or in the form of increased crop yield from the use of fertilizer for pre-planting treatment of seed.

The Silting Of Ridge Lake. *By* J. B. STALL, L. C. GOTTSCHALK, A. A. KLINGEBIEL, E. L. SAUER *and* S. W. MELSTED; *Ill. State Water Survey Div. Rpt. of Investigation No. 7. 1951.*

This is a report of a silt survey of Ridge Lake, a small recreation lake built in 1941, located in Fox Ridge State Park near Charleston, Ill. The lake has a drainage area of 902 acres; original lake area was 18.1 acres and original volume was 187 acre-feet. The survey shows a capacity loss of 1.29 per cent per year. In the 6.4-year life of the lake, sediment has destroyed 8.3 per cent of the original capacity. The lake has suffered an average annual loss of 120 cubic feet. The watershed suffered an annual loss of 4.4 tons of sediment per acre annually. The lake sediment contains a high level of available potassium and phosphorus indicating a relatively high fertility of the eroding soils.

Ohio Maple Syrup—Some Factors Influencing Production. *By* H. R. MOORE, W. R. ANDERSON *and* R. H. BAKER. *Ohio Agri. Exp. Sta. Resh. Bul. 718. August 1951.*

This study attempted to identify the combination of physical and economic circumstances favorable to profitable production of maple syrup in northeastern Ohio. It was found that variations in weather, particularly during the sap-flow season, resulted in uncontrollable fluctuations in maple sap yields. Any soil type producing vigorous maples can be a satisfactory site for sap production; but sugar content in sap was low on wet sites. Depth of soil was more important than slope of land and direction of exposure.

A large leaf-bearing area is associated with efficient sap production. Fast growing trees are usually good sap producers. Large trees are best producers. Volume of sap increases faster than tree diameter and sweetness of sap increases with tree size.

Supply Phosphorus To Range Cattle Through The Fertilization Of Range Land. *By* E. B. REYNOLDS, J. F. FUDGE *and* J. M. JONES; *Tex. Agr. Exp. Sta. Prog. Rpt. 1341. March 12, 1951.*

Fertilizer work with phosphates was started on the King Ranch in the spring of 1941 to determine whether the application of phosphates to grazing lands would increase the yield and phosphorus content of range grasses, and whether the fertilized grasses would provide adequate amounts of phosphorus for range cattle grazing them. The results obtained during the five years, 1941-46, show that the application of phosphate increased the yield and phosphorus content of the range forage and provided sufficient phosphorus for range cattle, except during periods of severe drouth.

Movement Of Water Vapor In Soils. *By* EDWARD L. BREAZEALE, W. T. MCGEORGE, *and* J. F. BREAZEALE; *Soil Sci., Vol. 71, No. 3, pp. 181-185. March 1951.*

This paper reports the results of studies on the utilization of vaporious moisture by plants. It was found that highly vegetative plants, such as tomato, can maintain turgidity and growth for an extended period with vapor as its only source of water. A technique is presented for demonstrating this phenomenon. When a supply of vaporous moisture was available the roots reduced the soil moisture well below the wilting percentage before a definite evidence of wilting appeared.

Description Of Motteling In Soils. *By* ROY W. SIMONSON; *Soil Sci., Vol. 71, No. 3, pp. 187-192. March 1951.*

A system is proposed for describing soil mottelings in terms of contrast, number, color, and size in ordinary field notes. It is also suggested that attention be given to boundaries and to shape or form in striking instances or in detailed morphological studies. Terms for characterizing motteled patterns are proposed.

Book Reviews

FUNDAMENTALS OF SOIL SCIENCE. *By* C. E. MILLAR *and* L. M. TURK. *Second Edition. 484 pp., illustrated. 1951. New York, John Wiley and Sons. $5.50.*

The soil conservationist who wants to keep up his profession cannot afford to neglect the standard textbooks on soil science. This is the second edition of a book first published in 1943. Another standard book, *The Nature and Properties of Soils,* is now in its fifth edition, with the authors listed this time as Lyon, Buckman, and Brady. *Soils and Fertilizers,* by Bear, and the new *Soils and Soil Fertility* by Thompson give perhaps briefer treatment of some of the fundamentals and more stress on some of the applied phases of soil science.

The general outline used by Millar and Turk in their second edition differs in only a few details from that of the first. A chapter of 33 pages on soil conservation has been added, and two short, specialized chapters on fruit soils and lawn soils have been omitted. The first three chapters of the earlier edition have been rearranged into five, and the entire text has been considerably revised and expanded. The result is a book that is valuable to the professional worker who wants to keep up with soil science as well as to the college student.

The book is described accurately by its title. It is an exposition of fundamentals, not a handbook of applied soil science. You find in it a good discussion of soil acidity, but no directions about how to make a particular pH test and decide how much lime to put on. The significance of the pH scale is explained, however; and all that is as it should be in a textbook of this kind. You find mention of the rapid diagnostic tests for nutrients in soils, but no information about specific tests and how to make them. That also is as it should be, for in college such subjects must be covered in advanced courses. The modest statement that interpretation of such tests is difficult and should be attempted only by experienced persons might well be memorized by soil conservationists and all who deal with farmers and gardeners

Outstanding parts of the book are those dealing with soil organisms, organic matter, cover and green-manure crops, and farm manures. In some of the other chapters the explanations could be improved. A better concept of soils would be given, for example, by a little less emphasis on the separates of mechanical analysis and more on the concept of a continuous size-distribution curve as the usual occurrence; by a discussion of the energy concept of soil moisture and the relation of moisture tension to the arbitrary divisions into gravitational, capillary, and hygroscopic water; and by some additional discussion of the variations that are tolerated as well as the homogeneity that is required within a soil mapping unit such as a soil type. Some facts about different clay minerals would help us understand why some soils shrink more than others when they dry out, and why soils differ in such properties as erodibility and base exchange capacity.

If you don't have one of the standard texts on soils in an edition printed within the last ten years, you will find it well worth your while to take a good look at this one.

—J. G. STEELE, *Washington, D. C.*

ENGLISH HUSBANDRY. *By* ROBERT TROW-SMITH. *Faber and Faber Ltd. 1950. 24 Russell Square, London. 18s.*

The path of English agriculture through a period of some 4000 years is traced by the author, in an excellent, well-documented narrative. It is a summary of British agriculture from earliest times to the present day. Naturally, most of the book is devoted to recent periods of technological advancement but it does not neglect the early history of English agriculture.

For the conservationist, "English Husbandry" is rich with the recorded experiences of many early and modern farmers that deal with subjects of soils, the first soil survey, early experiences with marl and lime, fertilizers, rotations, drainage, irrigation ditches, size and arrangement of fields, and numerous facets of historical significance. Among many other things, it shows the agriculture of pre-pastoral nomadism, that of temporary cultivation of small patches of land around villages, that of unimproved livestock, and the shifts from livestock to grain to livestock, the effects of the bronze and iron ages, the effects of conquerors and conquered, the economics and social problems of the times, the problems and concepts of landownership and tenure, the impact of the growth of the urban population on agriculture, the developments of tools, equipment, and machinery from the simplest types to the combine harvester.

One of the most interesting features of this book are the references used by the author in reporting upon the early experiments and experiences of farmers prior to the establishment of what we now know as the Agricultural Experiment Stations. Readers will be impressed by the manner in which many of these early farmers contributed to scientific progress. They are also bound to be impressed by the slowness with which proven technology was adopted on a widespread scale.

"English Husbandry" is an excellent historical reference, especially for those interested in English agriculture. The author includes a comprehensive bibliography.

—ALVIN C. WATSON, *Upper Darby, Penna.*

THE DAMMED MISSOURI VALLEY. *By* Richard G. Baumhoff. *Alfred A. Knopf, New York, 1951. Illustrated and indexed. 291 pp. $3.75.*

Garrison Dam in North Dakota will be the world's largest earthen dam on expected completion in 1955. Its volume will be 25 times that of the Great Pyramid of Egypt. Begun in 1946, the dam will be a half-mile thick at the base and the top, 210 feet above the river bed, will be wide enough for a public highway. Its concrete flood spillway is to be 3300 feet long and a two-mile channel will be dug to conduct flood waters back to the mainstream. Impounded water will constitute the largest reservoir in the world—200 miles long, 14 miles wide in some places, occasionally over 200 feet in depth, with a surface area of 609 square miles and a 1500-mile shore line.

The foregoing is a sample of what is going on in the dammed Missouri basin. Relatively speaking, it is an incidental episode in the drama that Richard Baumhoff calls the biggest story along the 2465-mile river—the story of management conservation and use of one-sixth of the U. S. A.'s continental area. Ultimately, Garrison is likely to be the only one of some 150 major structures for flood control, power and irrigation now at various stages from controversial debate to accomplished fact.

Baumhoff calls water the key to the future of this "valley of contradictions." This resonably safe assertion is evident in his narrative and in the frequent news headlines originating in the flood-and-drought plagued northern great plains. Public and private maneuvering and wrangling, planning and progress, hopes and disappointments related to working out a satisfactory program to develop the true richness of the Missouri are the fibers of this thesis.

In the tradition of an able reporter—he is a 34-year veteran with the *St. Louis Post-Dispach*—the author has not allowed the big dam arguments to obscure his coverage of upstream engineering, the supplementary potential of grass-roots argricultural soil conservation.

Aside from a mounting realization that he is face to face with one of the nation's biggest domestic issues, the reader continually finds himself inserting mental exclamation points throughout the 291 fast-moving pages. There is a marching column of facts about Big Muddy and its environs he probably never knew before: The stream flow has been measured at 34½ trillion gallons daily, contrasted to New York City's daily consumption of 1 1/5 *billion gallons*. The watershed average population density is nine people per square mile, as against New York's 30,000. The nation's leading grain-producing area, the Missouri basin, is strangely short of breweries.

Caribbean hurricanes roar across its confluence with the Mississippi, and the Arctic drops an ice-box on its headwaters in Montana. The most common call in local taverns is for a "ditch high"—translated into bourbon and water. Here are the U. S. A.'s largest coal deposits and possibly the largest source of uranium ores and rare oxides anywhere in the world.

Superlatives of the Missouri are endless and so, for the time being, seems the struggle toward its complete design for conservation. However, the conclusion Baumhoff draws from the saga is hopeful and highly quotable: ". . . The new agency, authority, commission, interstate union, or whatever it may be termed will not be satisfactory to the extremists on any side—to either the more radical MVAers or the more conservative private enterprise boys. Actually, it will not be greatly different in essence from an MVA shorn of some dubious elements. It might be what you could call an MVAAA: the Missouri Valley Anti-Authority Authority."

—Bernhard A. Roth, *Upper Darby, Penna.*

CROPS IN PEACE AND WAR. *The Yearbook of Agriculture 1950-1951, United States Department of Agriculture. 942 pages. For sale by the Superintendent of Documents, Washington 25, D. C. $2.50.*

"Crops in Peace and War" is a truly remarkable book. This 1950-1951 Yearbook takes us on a tour through a sort of wonderland of science in the field of processing, packaging, storage, transportation, and distribution of crops and animal products after they leave the farm.

The field of food products is a relatively small part of what this book covers. Still, if grandma returned to earth and visited a modern grocery store she would never believe what she saw. Frozen foods that are in handy packages, ready to be heated and served, would be one of the amazing sights. Incidentally, in her day, grandma discarded food that froze during severe winter weather because such food was considered unsafe for human consumption. Dressed chickens in cellophane, frozen strawberries, fresh string beans, cucumbers, lettuce, and many other summer vegetables that grandma would find on the shelves of the modern grocery store in winter would make her think her almanac had got the seasons mixed up. The different fruit juices and concentrates also would be new to her. All the talk she would hear among other shoppers about the vitamins and minerals in the different foods would be strange. Grandma never made the personal acquaintance of any of the vitamins. She knew that grandpa used certain minerals in fertilizing his crops, but she didn't know the family ate any.

Grandpa operated his farm with family labor and sometimes a hired man. He sold his farm products, ex-

cept cotton, direct to the consumer. In contrast with this, a modern farmer has a vast army of highly trained scientists and technicians working for him in laboratories and factories. His raw products are processed into more different items than could be named in the number of words that I am allowed in the review of this book. All of these trained workers are expanding the commercial field for crops and livestock.

The chemist, for example, may find a way to make a better product, or he may derive a new product from it. Take, for example, fats and oils derived from seeds and grains. Then, too, the chemist finds a way to treat one of these fats or oils so that it has better keeping qualities or some other characteristic that increases its usefulness.

In grandma's day, cotton and wool were the principal fabrics in common usage. A little silk was used in making Sunday-best dresses and linen was used in table napery. Jute for cotton bagging, fertilizer bags, and such things was almost the only other fiber of that day. Out of our modern research laboratories have come many man-made fibers from various farm products. Cellulose from wood and proteins from corn, soybeans, and even feathers, are being processed into new fabrics that expand the industrial possibilities of farm products and enrich the lives of people. Sometimes these new developments of our laboratories tend to upset, at least temporarily, the demand for cotton and other natural fibers.

The cotton section of this book is very interesting to one who has a Cotton-Belt background. There is room for hope that as we learn more about processing cotton fabrics to make them waterproof, to make them hold water, and to make them flameproof, and so on, we may greatly expand the use of this valuable fiber crop. Better methods of dyeing, resulting in cotton goods of greater beauty, is another contribution of the laboratory.

The forest-products section describes many uses of wood and its derivatives that were unknown until fairly recent years. Knowledge gained in the research laboratories is helping processors to make a very imposing list of products from wood. Cellulose and hemicellulose from wood are being combined into a host of new products. The whole story is worth reading. You will particularly enjoy the chapters about wood and wood products.

No effort has been made to give any systematically organized description of "Crops in Peace and War." I simply have tried to throw in a few highlights to illustrate the great wealth of useful and interesting information the book contains. I like it because it gives me in a single volume the material that I would have to go through a whole library to find. If you don't have your copy, you'd better get it. You'll like it.

—R. Y. BAILEY, *Spartanburg, S. C.*

Let There Be Bread. *By* ROBERT BRITTAIN. *Simon and Schuster, N. Y., 243 pages. 1952. $3.50.*

Here is another of the several books that are currently assuring us that man has it within his power to feed the 4000 million people who may live upon the earth within the lifetime of the rising generation. There are two parts. Part One: World Enough, discusses potential use of deserts, the Far North, the habitable tropics, and the sea as sources of food. Part Two: Food Enough, shows how food can be increased by water (river) management, land management, disease and insect control, and new crops.

New Hopes for a Changing World. *By* BERTRAND RUSSELL. *Simon and Schuster, New York, 213 pages. 1951. $3.00.*

A distinguished English thinker herein summarizes man's problems as relationships between (a) man and nature, (b) man and man, and (c) man and himself. Each subject forms a part in the book. The soil conservationist will find Part One most directly interesting for the comments on the population-resource relationship as viewed by a great mathematician-philosopher. The remainder of the book is thought-provoking and challenging as well. Russell calls for an international authority controlling the production and distribution of food and raw materials, as well as population control.

Land for Tomorrow: *The Underdeveloped World. By* L. DUDLEY STAMP, *Indiana University Press, Bloomington, Ind., 230 pages. 1952. $4.00.*

An English geographer, lecturing in the United States, turns his attention to the problem of "matching the world's use of its natural resources with the needs of its people." Several interesting facts and points of view are presented, such as the increase of the world's white people, within the past century, at a rate four times that of the world's people as a whole, and the fact that, in terms of food production potential, the United States, Argentina, and Canada are the real underdeveloped regions, not Asia, Africa, and most of Latin America.

The Progress of Forestry—1945 to 1950. *American Forestry Association. Washington, D. C. 1951. 90 pages. $3.00.*

This publication records great progress in most but not all lines of forestry endeavor during the half-decade since the Association's American Forest Congress of 1946. Typical of its 90 pages of trends and vital statistics are the following facts:

An additional 56 million acres were put under fire protection; insects and diseases caused three times the

forest damage as that of fire, receiving one-fifth the funds available for fire; 30 states indicate a striking three-fold increase in state outlays, with the 1949 total at $31 million; acceptance and application of forestry principles reached the greatest heights in American forestry.

The Geography of Hunger. *By* JOSUE DE CASTRO. *Little, Brown and Company, Boston, Mass. 1952. 312 pages. $4.50.*

Dr. de Castro, in this well documented book, believes the world capable of providing an adequate diet for the more than two billion ill-fed people. This is the reverse of the arguments advanced for birth control by Vogt, Cook and others. The author also points out that the production of food could be increased in the poorer countries through the use of modern farm equipment, hybrid crops, soil conditioners such as Krilium and the desalting of sea water.

A Conservation Song. *Words by* ERNEST D. WALKER, *Music by* PAUL M. SOMERS. *Chapter Supply Company, Danville, Illinois. 1950.*

Remember Old MacDonald, the fellow who had a farm that has been sung about by supper clubs, school groups, 4-H and others? He has been given a new lease on his musical life—and with new meaning.

The Tune Tinkers of Urbana, Illinoins, have been singing a conservation song about Old MacDonald that has been catching on and finding ready acceptance in the mid-west. Words are by Ernest D. Walker, Extension Soil Conservationist for Illinois, and the musical arrangement was done by Paul M. Somers.

As would be expected, the words tell of badly washed soil, with a "*gully here and a gully there*" then a changed picture with the arrival of contour farming and crop rotations.

Now "*Old MacDonald's feeling gay*" because "*he farms the conservation way.*"

The music is catchy and is in B-flat, placing it in a singable range for adults and children, too.

The Missouri River Basin Proposals for Development. *By* MARVIN MEADE. *Bureau of Government Research, University of Kansas, Lawrence, Kansas. 69 pages, 1952.*

This pamphlet contains detailed explanations of the various patterns of watershed development including the Ohio Conservancy district, the Salt-Wahoo and the overall Missouri Valley Basin approach. Mr. Meade, author of the pamphlet, also describes in detail the basin programs under the Pick-Sloan Plan, the proposed Missouri Valley Authority Plan and the Watershed Management Plan, with arguments for and against each.

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Conservation Films

Where the Floods Begin. *Color and Sound. 16 millimeter. Running length 16 minutes. The Public Service Company of Oklahoma. Tulsa.*

This film deals with Soil Conservation and water retardation on the watershed of the Washita River in Western Oklahoma. The film "Where The Floods Begin" was made and produced by this Company in Cooperation with the U. S. Department of Agriculture, Soil Conservation Service. It shows the revegetation practices as well as the construction of detention reservoirs and gulley plugs on several creeks which flow into the upper Washita River.

Man on the Land. *Color, sound-on-film; 16 and 35 Millimeter. Running length 16 minutes. Oil Industry Information Committee, American Petroleum Institute, 50 West 50th Street, New York 20, New York.*

The dramatic story of how man has been able to wrest today's high standard of living from Nature and the Land is the theme of the Oil Industry Information Committee's motion picture, "Man on the Land." It emphasizes that throughout all history, man has been able to prosper and progress only in those periods and places where he has been free to work, think and produce in a competitive atmosphere. It tells the story of agriculture from the time that man first scratched the earth with a forked stick to the present age of oil-powered tractors, petaroleum fertilizers, insecticides and other petrochemicals with which he is making the very desert "blossom like a rose," as the Bible predicted.

FIELD NOTES AND COMMENTS

Conservation Education Is Taught By Using National Surroundings

Down in Anderson County, South Carolina, there is a miniature soil and water conservation society. Its members are one section of the sixth grade in the Southside Grammar School. They operate without a charter. Their interest in the conservation of natural resources is informal—almost spontaneous.

The leader of this group is a rare gem of a public school teacher, Mrs. Mary E. Ellis. It was my privilege to hear her tell the remarkable story of how she teaches sixth-grade boys and girls an appreciation of natural resources.

The amazing thing about this budding society in the field of conservation is that its members are from the homes of textile employees—only one class member lives on a farm. In spite of this, Mrs. Ellis leads her children into a remarkably clear concept of what natural resources mean in their present and future lives. For example, these youngsters made their own application of the interdependence of land and industry. If the land is destroyed, they reasoned, textile plants can't get cotton. Their parents will be out of work. They will suffer.

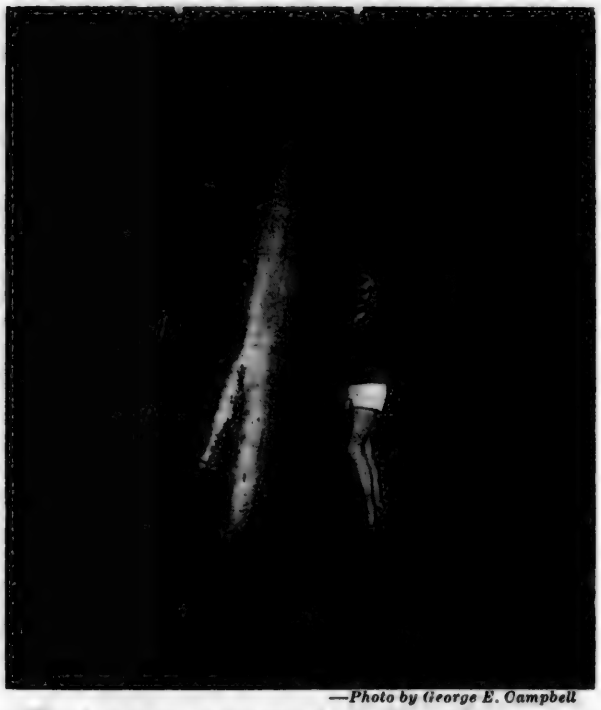
Mrs. Ellis does not teach in a richly endowed school with unlimited classroom and laboratory facilities. The school has no auditorium and when her class is host to another class of children in the school, they "sit double" so as to make room for the visiting children. Their laboratory is the school grounds where they study soil and plants. When, for example, an excavation was made for some purpose, this sixth-grade class studied the soil profile and got a better idea about the thinness of the layer of topsoil from which their food, clothing, and shelter come.

I was surprised to learn that English is the course to which Mrs. Ellis relates her conservation teaching. She begins with new words that are added each day to the vocabularies of the children in her class. She skillfully introduces conservation of natural resources through these words. Children learn the meaning of the words that are associated with conservation and Mrs. Ellis helps them relate these words and their conservation meanings to their everyday lives. My best descriptive effort is that she develops in the minds of these children an intelligent awareness of their natural surroundings.

These sixth graders write compositions about subjects in conservation. They improvise decorative covers for these compositions. These covers nearly always depict the good and the bad in the use and treatment of land. The children also improvise many problems in their arithmetic lessons. They usually show that conservation farmers in their problems make money and that non-conservation farmers lose money.

Religious training and conservation teaching are also correlated. Children read selected passages from the Bible, "The Lord placed Adam in the garden to dress it and keep it; The Earth is the Lord's, and the fullness thereof"; and "The cattle on a thousand hills are His."

The annual highlight of Mrs. Ellis' conservation course is a one-day field trip by bus, usually to the State Agricultural College at Clemson. Children of the class



—Photo by George E. Campbell

The above photograph was judged a blue ribbon winner at the International Flower Show, Hollywood Park, California, March 22-30, 1952.

The tree in the picture is one of the first Blue Gum (*Eucalyptus Globulus*) planted in California. It was grown from seed that was brought from Australia by clipper ship in 1852, one hundred years ago. Some of the original seedlings were planted at the headquarters of the Alfred Workman Ranch in the San Fernando Valley.

The Blue Gum has proven to be very useful in the Soil and Water Conservation Program. Since it is an evergreen tree and grows very rapidly, it will provide an effective windbreak in only a few years. It is also useful in woody plantings of eroded hillsides and gullies. Though the Blue Gum will tolerate considerable drought and cold, certain other Eucalyptus species will withstand greater extremes of both drought and cold. The Blue Gum is adapted best where the soil is deep and the temperature does not drop below 18° F. Planting stock is easily grown from seed.

write all letters and make all telephone calls in arranging this trip. Each child pays bus fare and buys his or her lunch at one of the College mess halls. Attendance is a hundred per cent—a worthy goal for Soil Conservation Society of America chapters.

Members of this little society invite another section of the sixth grade to make the field trip, but in a separate bus. They want to ride with their own kind so that they may have stimulating discussions about conservation as they observe things along the road. Only those who shared their training in conservation can discuss the subject enthusiastically and expertly.

Children in Mrs. Ellis' class visit other classes following their field trip and tell what they saw. In this way they function as a juvenile soil conservation society. They have learned something that is good—they pass it on to others.

Fifth-grade students in the school look forward to next year when they will be sixth graders. I was told that these children want to get in *the* sixth grade—Mrs. Ellis' section. Thus, children in their own way pay this gifted, earnest teacher their highest tribute.

If we ever get around to honoring teachers who are doing outstanding work in teaching children for well-rounded, informed citizenship, Mrs. Mary E. Ellis already has my nomination.

—R. Y. BAILEY, *Spartanburg, S. C.*

Herting's "Rite-Rack"

A combination publications rack—blackboard that folds and carries like a valise—has given good service to several New York Soil Conservation Service technicians during a year of farm meetings. The "homemade" device pictured here originated with G. Claire Herting, district conservationist at Fort Edward. Each of the two-section interiors has compartments holding supplies of more than 20 different publications and bulletins, as well as other information aids. Fully opened, the exterior provides a 2′ x 6′ blackboard writing space, suspended from screw eyes installed along the top, or resting on a table. End hinge bolts can be removed for independent use of either section. Valise-type handles make it easy to carry and a hook-and-eye latch keeps it from opening in transit. Herting says the main surfaces can be plywood or masonite, but specifies that two or three coats of genuine *blackboard paint* are essential, along with generous sanding of the writing surfaces. Dowel, stock lumber, varnish and hardware needed to complete construction make this an inexpensive item for conservation evangelists. If further details are needed, write the Editor of the JOURNAL.

Publications stay neat and clean when carried and presented in a Rite-Rack. Simply turn it around and the Rite-Rack is a blackboard, the focal point for group discussions.

Twenty-three Farmers Establish Neighborhood Conservation Program

The question is still being asked: Does conservation pay? And the evidence is still mounting that it does!

The Kansas flood of early July, 1951, will likely never be forgotten—certainly not by those caught in it, but the excessive rainfall proved that conservation measures can be successful even against such deluges.

Back in 1932 a "ditch" was constructed to handle the runoff from a watershed area of 2500 acres of upland about three miles east of Salina, Kan. to the Saline River. It was not a solution to the problem, for it rapidly filled with sand. County authorities agreed to clean it, but only once and then on condition that land owners would work out a definite plan to prevent re-silting.

The ultimatum resulted in a well-planned attack on run-off water. The Schippel drain, a man-made stream, came into existence. Fifteen farmers on the bottomland, where 2500 acres had been damaged frequently by floods, were joined by eight others in the upland watershed. What happened during the fateful week of July 5 to 12, 1951?

Despite the more than ten inches of rainfall in a two-day peak period, the drain did not overflow its banks anywhere from its source until the flooded Saline River level was reached. And there was no overflow on the land the drain was designed to protect except where the Saline River came out of its banks.

James H. Payne of the Soil Conservation Service made the original survey and prepared the conservation program. His proposal included series of detention dams with the release of flood waters through drop-inlet pipes connecting the dams.

The cost was approximately $4 per acre. Farmers in the uplands pooled their PMA allotments, which raised half the amount needed. Bottomland farmers raised the other half. Salina's Chamber of Commerce organized a "Soil Saving" day which included an impressive demonstration on one farm of how the watershed conservation plan would work. The plan was practically completed in 1950—but the big test did not come until last July. Even before that, in May and June, there had been abnormal rainfall, totaling almost as much in that short period as usually is experienced in a full year.

One of the cooperating watershed farmers, D. R. Hagadorn, had this to say:

"I have looked over my farm carefully and cannot see where any damage occurred from those rains. There are no breaks in my terraces and there has been only a minimum of silting in the terrace channels. No water ran through the detention dam spillway the first night (July 10). All of it was released through the pipe. Just a little ran over the spillway for a short period the second night (July 11). The flood runoff just could not rush on its way; it had to take its time going through the pipe."

Other farmers along the Schippel drain gave similar testimony. And just a few miles away were scenes of the most extensive flood damage Kansas had ever experienced.

Mr. Hagadorn concluded his observations with this:

"We have profited by this conservation plan—saving water, preventing damage, and laying the groundwork for land improvement, which means a better living through higher profits."

Camera Plus Technician, Aid To Good Range Management

The management of grazing livestock on the mountainous ranges of the national forests is complicated. For example, cows like to graze best on valley bottoms and sheep prefer the same bedground every night. They also like to feed out in the open. As a result of these and other livestock grazing habits, the Forest Service range managers have to be on the watch to see that grazing use is not concentrated. The goal is to get the forage plants properly and evenly utilized on all usable range.

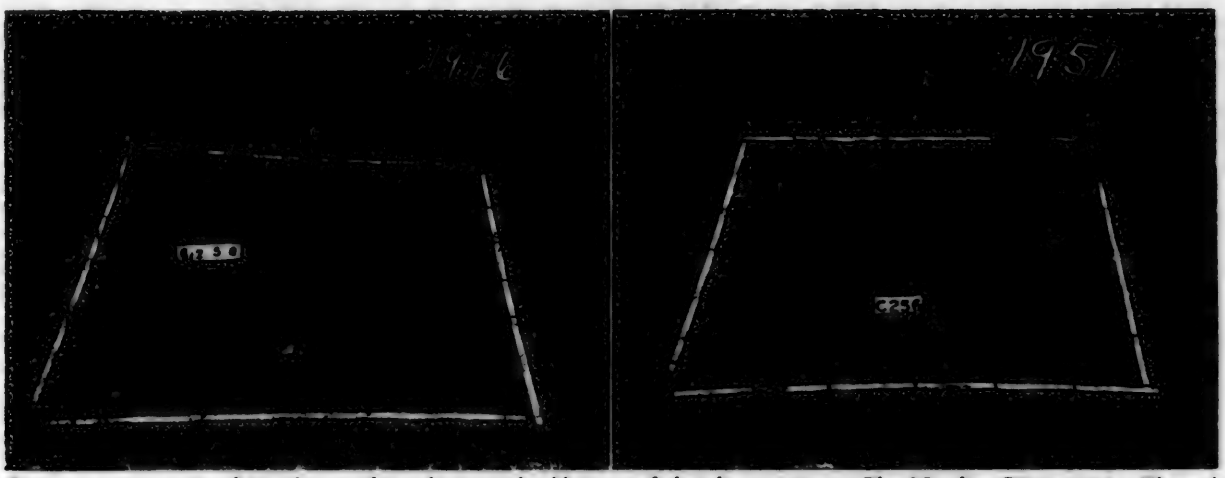
This accomplishes two objectives of good range management: (1) It tends to prevent damage to the range plants and, (2) harvests all the forage available for livestock use.

But even with good distribution of stock, if there are too many sheep or cattle for a particular piece of range, they not only eat what should be harvested, but damage the plants that need to be left to insure future forage crops. In other words, *they destroy the capital investment when you regard the forage plants are capital and the yearly growth as interest.*

After a careful study, practical range foresters and scientists of the Intermountain Forest and Range Experiment Station evolved a method to help the forest rangers record the results of livestock grazing.

Project Started in 1942

The Photo Plot Transect Method of range study was born in 1942. It is expected to answer some definite questions about the national forest rangelands of the Intermountain Region. These are: (1) Is the kind of grazing being done, wearing out the soil and range plants? (2) Is the grazing proper so that the plants are maintaining themselves and the range will continue



Slender wheatgrass, a choice forage, formed a considerable part of the plant species on Plot Number C256—1946. The soil is fairly well covered. Tarweed is present in some numbers. The plot on the right now shows deterioration. Slender wheatgrass plants are almost gone. The space occupied by plants is less and more soil surface is exposed to erosion by wind and water. There are some coneflower seedlings. Snakeweed, unrelished by livestock, has become established and four other species of annual weeds are present.

Bare and eroded with little vegetation, Plot Number C222—1946 contained a few lupines and 35 knotweed plants. Most of the soil was exposed and subject to erosion. This plot is on an area which has been fenced to exclude grazing by livestock. Five years later under continued complete protection from grazing by livestock, records on Plot Number C222—1951 show that natural recovery has begun. Lupine, still the main plant species, nearly covers the plot. A needlegrass plant has become established and there are now 100 knotweed plants. The soil is better covered and therefore less subject to erosion.

producing at full capacity? (3) If the range is worn out is it able to restore itself through natural process of plant recovery, natural reseeding, and soil healing?

Here's how the job is being done. It completely eliminates guesswork and reliance on memory, and is a precise working tool for range and soil managers. On a straight line across the range to be studied, iron pegs at set intervals mark the plot positions and the two diagonal corners of plots. An iron peg also marks a fixed camera point at each plot. Once established, it is a matter of photographing the plots at 5-year intervals. Other accurate information taken plus the photographs answers the three questions: (1) Is the range holding its own? (2) Is it going downhill? (3) Or is it recovering? One plot alone does not tell the story but the information from all the plots on an area gives reliable accurate data.

Spread over key grazing areas on the 20 national forests of the Intermountain Region, today are 210 of these photo plot transects. Their function, the Forest Service says, is to provide a check on changes in range condition of sheep and cattle grazing allotments. (A grazing allotment is the area of national forest range assigned to an individual or to a group of stock raisers for grazing their livestock during a stated season.)

Better Management Is Objective

To date, 133 of these transects have been rephotographed and recharted since they were established. The factual information obtained is already helping the forest rangers plan better management of the region's valuable national forest grazing lands. In Photo Plot Transects the Forest Service feels that it has a valuable working tool which answers many questions and eliminates guesswork about the trend and condition of the soil and plant cover on our mountain watersheds.

Photos taken in addition to those of the individual plots include a general view of each transect line showing its relative location. Slow changes in plant cover are thus recorded. The outstanding features along the transect are also photographed. These would be erosion, hedged shrubs and other distinctive features showing soil and plant characteristics.

On the individual plots, the relative area occupied by each species is charted. Species are identified by number. Other observations recorded are information on the soil, erosion pavement, litter, extent of erosion, pedestalled plants, and rodent damage. Plants scattered uniformly are counted as number per square foot. For a group or clump of plants the area is outlined; single plants are shown by a dot on the chart.

General observations made that might not be included in the plot data are hedged condition of shrubs, and amount of current utilization by livestock game animals.

The Centennial of Engineering

The one hundredth anniversary of the founding of the first national society of civilian engineers in the United States, the American Society of Civil Engineers, was celebrated recently throughout the country. Locally-sponsored events throughout the country will be climaxed in the Chicago Convocation, September 3-13. This convocation will be under the joint sponsorship of all the Nation's principal engineering societies.

The Convocation will bring together many of the world's outstanding engineers to participate in the various symposiums which will emphasize the highly significant part played by engineering in developing the United States to its position of world leadership. More than 100 speakers, engineers and laymen will present the story of the social, economic, and political effects of the accomplishments of engineers operating in a free enterprise system—the results of a century of engineered progress.

McArdle Appointed Chief of Forest Service

Secretary of Agriculture Charles F. Brannan has appointed Richard E. McArdle as chief of the Forest Service, U. S. Department of Agriculture. He will succeed Lyle F. Watts, chief forester for the past nine years, who retired from active duty June 30.

Mr. Watts' retirement from active duty as chief of the Forest Service will mark the completion of a public career service of nearly 40 years. He has headed the Federal forestry agency since 1943.

Mr. McArdle has been a member of the Forest Service for more than 25 years. Since 1944 he has served as assistant chief in charge of cooperative forestry programs. Under his leadership, the Federal programs carried on in cooperation with the States to encourage and facilitate the protection and sound management of the country's forests have been greatly accelerated.

International Association Hydraulic Research

The International Association for Hydraulic Research has announced that the 1953 meeting will be held at the St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minn., during the week beginning August 30, 1953. Subjects to be discussed will be restricted to density currents; air entertainment by flowing water; waves, beach erosion, and hydromechanics of shore structures; and basic relationships of sediment transportation by flowing water. It is planned to schedule the meeting jointly with a meeting of the Hydraulics Division of the American Society of Civil Engineers.

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In the NITRAGIN greenhouse, scientists check the effectiveness of different strains of legume bacteria. Comparison of data gained from laboratory analysis of the nitrogen-fixing ability of each bacterial strain, permits the selection of the most effective strains for use in NITRAGIN inoculant. Continuing research in the NITRAGIN laboratories helps to further conservation . . . by increasing the value of legumes and inoculation as a means of holding the land and reducing erosion. NITRAGIN is always glad to cooperate with scientists working in this field.

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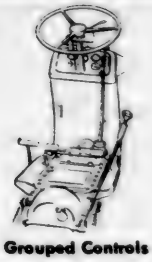

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Double-Disc Brakes

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Terraces . . . contoured strips—both are familiar practices in controlling water and holding soil.

But, to work them requires constant maneuvering of some sort—following winding contours, making short turns, cutting back to catch point rows.

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SOIL AND WATER CONSERVATION GLOSSARY

Prepared by

THE SOIL CONSERVATION SOCIETY OF AMERICA

SECTION III

Precipitation—(1) A general term for all forms of falling moisture which more specifically include rain, snow, hail, sleet and their modifications. (2) The quantity of water that is precipitated. The amount of precipitation during some unit of time such as a day, month, or year is generally expressed in depth (measured as liquid water) precipitated upon a horizontal surface or into a gage having a horizontal opening. (3) The process by which water in liquid form is discharged out of the atmosphere, upon a land or water surface.

Precipitation, Excessive—(1) Rainfall in which the rate of fall is greater than certain adopted limits, chosen with regard to the normal precipitation (excluding snow) of a given place or area. In the U.S. Weather Bureau, it is defined, for states along the southern Atlantic coast and the Gulf coast, as rainfall in which the depth of precipitation is 0.90 inches in 30 minutes, 1.50 inches in one hour; and for other parts of the U.S. as 0.50 inches in 30 minutes and 0.80 inches in one hour. (2) The accumulated amount of precipitation for each 5 minutes during all storms in which the rate of fall equalled or exceeded 0.25 inch in any 5 minute period, or 0.30 inch in any 10 minute period, or 0.35 inch in any 15 minute period, etc. The storms in which excessive precipitation occurs are called *Excessive Storms.*

Precipitation, Trace of—An amount not large enough to be measured in a gage. Usually less than 0.005 inch.

Premature Grazing ***(Range Management)***—Grazing before important forage plants have reached a sufficient state of maturity, and on spring ranges, before soil has become firm enough to prevent a cumulative injury to the range under prevailing degree of stocking. Contrast with *Range Readiness*

Prescribed Rights ***(Water)***—See Water Rights.

Pressure Head—The head on any point in a conduit represented by the height of the hydraulic grade line above that point.

Priming—(1) The first filling of a canal, reservoir, or other structure with water; that is, either the absolutely first or the seasonally first. (2) Starting the flow, as in a pump or siphon.

Priority ***(Range Administration)***—Preferred right entitling the holder to special consideration over other applicants and to a pro-rata share of available uses.

Problem Area in Soil Conservation—An area that is essentially uniform in physiography, climate, and soils, or has a characteristic pattern of these features; and that because of its physical features is a significant area in planning or carrying out soil conservation work in a county or other work area, a state, a region, or the Nation. Two or more separate bodies of land that have similar patterns of physical features are considered as parts of the same problem area. A map of Problem Areas in Soil Conservation in the United States, prepared by the Soil Conservation Service, has 155 problem areas delineated. Maps of regions, states, and of counties or other work areas have been prepared, on which the problem areas shown on the National map are subdivided into areas significant at the scale of delineation. Problem areas differ greatly in the kind and magnitude of conservation problems and conservation needs. Syn. *Land Area Significant in Soil Conservation.*

Proper Stocking ***(Range Management)***—Rate at which livestock are placed in a pasture or other management unit which will bring about use of range forage and other resources without injury to the range. In cases of deteriorated range the intensity of use would be such as to bring about an improvement to the range. Contrast with *Overstocking; Understocking.* See *Use, Actual.*

Proper Use Factor ***(Range Management)***—As applied to an individual species, the maximum percentage of the total year's forage production within easy reach of livestock which may be grazed without damage to the species, important associated plants, or the soil. As applied to a range type, the weighted average of the proper use factors of the individual species present.

Protection Forest—An area wholly or partly covered with woody growth, managed primarily for its beneficial effects on soil and water conservation rather than for wood or forage production.

Pruning ***(Forestry)***—The removal of the lower branches from young trees, in order to obtain logs with fewer knots when the trees mature. See *Self-Pruning.*

Public Domain—Land, for which the title was originally vested in the United States Government by virtue of its sovereignty. The public domain included much of the land east of the Mississippi River, and all land west of the Mississippi River except Texas. More than half of the original public domain has been granted to states, homesteaders, railroads, or has been sold. The remainder is land set aside for national forests, national parks, national monuments, Indian reservations, grazing districts, and similar purposes.

Puddle Soil—A dense soil dominated by single grain structure, almost impervious to air and water. This condition results from the handling of a soil when it is in a wet, plastic condition, so that when dried, it becomes hard and cloddy.

Puddling—The act of destroying soil structure. Puddling reduces porosity and permeability. This process is sometimes used to reduce leakage of reservoirs and canals.

Pure Forest—A forest composed of trees of one species. In practice, a forest in which at least 80% of the trees are of one species. Contrast with *Mixed Forest.*

Q

Quadrat—A small square plot or sample area usually either one square meter or one mil-acre in size.

R

Rain—Precipitation occurring in the form of liquid drops or droplets large enough to attain a sensible velocity.

Rainfall—The amount of water falling from the clouds during a rainstorm. Syn. *Precipitation.*

Rainfall Excess ***(Hydraulics)***—The volume of rainfall that will occur as run-off.

Rainfall Intensity—The rate at which rain is occurring at any given instant, usually expressed in inches per hour. *Maximum Rainfall Intensity* refers to the rate during any time when the rate is both maximum and uniform. Usually one or more standard time periods such as 5 minutes, 10 minutes, are specified and then the term refers to an average rate calculated from the maximum amount that occurred during any such time period and the rate is not necessarily uniform.

Ranch—An establishment or estate including lands and facilities used for the production of livestock. Accepted western usage generally refers to the headquarters facilities, pastures, and other land as the ranch, as distinguished from range.

Ranch Conservation Plan—See Farm or Ranch Conservation Plan.

Range—(1) Land that produces primarily native forage suitable for grazing by livestock. Also, forest land producing forage. Usually relatively extensive areas of land suitable for grazing, but not suitable for cultivation, especially in arid, semi-arid, or forested regions. Contrast with *Pasture.* (2) A unit of grazing land used by an integral herd of livestock. See *Open Range.* (3) The geographic area of occurrence of plants or animals.

Range Count—A census made on the range of the animals using a grazing area as contrasted to feedlot, corral, driveway, or similar counts.

Range Improvement—Any means employed to increase the utility and ease of management of the range such as development of water supply, fencing, revegetation, and control of noxious plants.

Range Management—The scientific management of range land for the continuous production of forage and livestock, consistent with the use of the land for other purposes. See *Range Improvement; Use, Proper.*

Range Plant Cover—All herbaceous and shrubby plants within easy reach of livestock on a range regardless of whether or not they constitute forage. Contrast with *Cover, Vegetation* which includes all plants.

Range Readiness—The stage of growth of the important palatable plants on the range and the condition of soil which permit grazing without undue compacting of the soil or endangering the ability of the plants to maintain themselves. Contrast with *Premature Grazing.*

Range Site—An area of range sufficiently uniform in climate, soil, and topography to result in a particular climax vegetation.

Range Survey—A systematic and comprehensive inventory and analysis of the range resources and related management problems of a range area, and developing plans for management. Such surveys are intensive or extensive depending upon the degree of sampling and size of type or sub-type areas recognized and mapped. Syn. *Grazing Survey.* See *Square Foot Method; Weight Method.*

Rating Curve—A graphic or sometimes tabular representation of performance or output under a stated series of conditions. For example, a rating curve for a flume shows volume of flow per unit time at various stages or depths of flow.

Rating Flume—An open conduit built in a channel to maintain a consistent regimen for the purpose of measuring the flow and developing stage-discharge relation.

Ration—The amount of feed allotted to a given animal for a 24-hour day. It may be fed at one time or in portions at different times during the day.

Ration, Balanced—A ration which furnishes the various essential nutrients in such proportion and amounts that it will properly nourish a given animal for one day.

Rational Run-Off Formula ***(Hydraulics)***—A formula used to predict stream discharges from small drainage areas.

$$Q = C\ I\ A,$$

where Q is the peak discharge in cubic feet per second; C is a run-off coefficient generally considered as that part of the rainfall rate which will contribute to the run-off rate; I is the average intensity of the rainfall in inches per hour during the time required for all parts of the watershed to contribute to run-off (period of concentration); and A is the area of the drainage basin in acres.

Reaction, Soil—The degree of acidity or alkalinity of a soil. A soil may be described as having an "acid reaction," or an "alkaline reaction." Generally expressed in terms of pH.

Recession Curve ***(Hydraulics)***—A graph representing the decreasing rate of flow in a stream channel, including both surface run-off and ground-water run-off. The descending curve of a hydrograph of stream flow. Contrast with *Depletion Curve.*

Recording Gage—An automatic instrument for making a graphic record of quantities or conditions like flow, stage, rainfall, and temperature in relation to time.

Reforestation—The re-establishment of forest trees on a previously cleared area.

Refuge—An area designated for the protection of animals, birds, and fish, within which hunting or fishing is either prohibited or strictly controlled. See *Game Refuge.*

Regimen—The stability of a stream and its channel. A river or canal is "in regimen" if its channel has reached a stable form as the result of its flow characteristics.

Regression ***(Statistics)***—A statistical method for studying and expressing the change in one variable associated with and dependent upon changes in another related variable or set of variables.

Residual Soil—Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials. Presumably developed from the same kind of rock as that on which it lies.

Retard—One of a series of permeable spurs built out into a stream channel approximately at right angles to the bank line. The purpose is to deflect the main current away from and stop caving of the stream bank, and to encourage the formation of bars along the bank.

Retention—The amount of precipitation upon a drainage area that does not escape as run-off. It is the difference between total precipitation and total run-off.

Revetment—A structure or obstacles placed along the edge of a stream to stabilize the bank and to protect it from the cutting action of the stream. May be solid and permanent, or temporary, such as dead trees and brush held in place until live vegetation can stabilize the banks.

Rhizome—A horizontal underground stem, usually sending out roots and above-ground shoots at the nodes. Quackgrass has rhizomes. Also known as *Root Stock.*

Ridge Terrace—A long, low ridge of earth with gently sloping sides, and a shallow channel along the upper side, to control erosion by diverting surface run-off across the slope instead of permitting it to flow uninterrupted down the slope. Types of ridge terraces include the broad base, drainage, graded, level, Magnum, narrow base, and Nichols terrace. Contrast with *Bench Terrace.*

Ridging for Irrigation—Making small embankments or borders in fields to control irrigation water.

Rill Erosion—Removal of soil by running water with formation of shallow channels that can be smoothed out completely by normal cultivation. See *Gully; Gully Erosion.*

Riparian Land—Land situated along the bank of a stream.

Riparian Rights—See *Water Rights.*

Riprap—Broken stone placed on earth surfaces such as the face of a dam or the bank of a stream, for their protection against the action of water (waves); also applied to brush or pole mattresses, or brush and stone, or other similar materials used for soil erosion control.

Roadside Erosion Control — See Highway Erosion Control.

Rock-Fill Dam—A dam composed of loose rock usually dumped in place; often with the upstream part constructed of handplaced, or derrick-placed rock and faced with rolled earth or with an impervious surface of concrete, timber, or steel.

Rodent Control—The reduction in numbers of rodents injurious to soil and water conservation structures and to crops, forage, and other useful plants by tillage, poisoning, trapping, and other methods which destroy rodents or control their increase.

Rollway—The overflow portion of a dam; an overflow spillway.

Root Zone—That part of the soil invaded or subject to invasion by plant roots under normal conditions.

Rotary Pump—A displacement pump for raising a liquid by the use of rotating elements instead of by pistons. It may operate at almost any speed and does not depend on centrifugal forces to lift the water.

Rotation—See Crop Rotation.

Rotation Grazing—Grazing two or more pastures, or parts of a range in regular order, with definite recovery periods between grazing periods. Where only two fields are involved, sometimes called *Alternate Grazing.* Contrast with *Continuous Grazing.*

Rotation Irrigation—A system by which each irrigator receives his allotted quantity of water not at a continuous rate, but at stated intervals. For example, a number of irrigators receiving water from the same lateral may agree among themselves to rotate the water, each taking the entire flow in turn for a limited period. Contrast with *Continuous Delivery.*

Rotation Pasture—A cultivated area used as a pasture one or more years as a part of crop rotation. Contrast with *Permanent Pasture.*

Roughage ***(Feed)***—Feed with high fibre content and low total digestible nutrients as hay and stover.

Roughness Coefficient ***(Hydraulics)***—A factor in the Kutter, Manning, and other flow formulas representing the effect of channel roughness upon energy losses in the flowing water. It is sometimes referred to as retardence value or factor. It is a variable factor depending on the roughness or smoothness of a channel lining, the mean hydraulic radius, mean velocity, and the slope. In a grass lined channel (terrace outlet) it varies as the product of the velocity times the hydraulic radius for a given channel.

Row Crop—A crop planted in rows relatively far apart, usually 2 to 4 feet, to allow cultivation between rows during the growing season.

Run-Off ***(Hydraulics)***—That portion of the precipitation upon a drainage area which is discharged from the area in stream channels. The water which flows over the land surface without sinking in is called *Surface Run-off* or *Immediate Run-off;* that which enters the ground before reaching surface streams is called *Ground-water Run-off* or *Seepage Flow From Ground Water.* In non-technical litera-

ture, the term Run-off is frequently used when referring to surface run-off, although precisely it is the total run-off, including both surface and groundwater run-off.

Run-Off Coefficient—See Rational Run-Off Formula.

Run-Off Plots—Areas of land, usually small, arranged so the portion of rainfall or other precipitation flowing off and perhaps carrying soluble materials and soil may be measured. Usually the flow from run-off plots includes only surface flow.

S

Safe Velocity *(Hydraulics)*—The maximum velocity of flow of water which will not cause erosion in a channel, depending on the characteristics of the channel.

Safe Yield—The rate at which water can be withdrawn from an aquifer, in acre-feet per year or other terms, without depleting the supply so that recovery is no longer economically feasible.

Saline Soil—A soil containing sufficient soluble salts, usually chlorides and sulphates, that the growth of most crop plants is reduced. It is not highly alkaline, pH less than 8.5. The soil is flocculated and has favorable structure thus allowing movement of air and water. Saline soils have been called "white alkali" due to the quite common formation of white or gray salt crustations on the surface. Contrast with *Alkali Soil.*

Salt Grounds—Areas where salt is placed for consumption by livestock.

Sample, Random—A sample drawn without bias from a population in which every item has an equal chance of being drawn.

Sample, Representative—A sample drawn in such a way that it gives a true value for the population from which it was drawn.

Sample, Stratified—A sample consisting of subsamples from subdivisions or strata of a population. The subsample may be random. Often used when the total population tends to be heterogeneous and the strata approximate homogeneity.

Sample Plot—An area of land, usually small, to be used for measuring or observing performance under existing or applied treatments. It may be temporary or permanent.

Sand—(1) Mineral soil grains 2.00 to 0.05 mm. in diameter according to U. S. Department of Agriculture standards; 2.00 to 0.02 mm. according to the International System. (2) Soil material containing 85% or more sand; percentage of silt, plus 1½ times the percentage of clay, shall not exceed 15.

Sand Trap—A device, often a simple enlargement, in a ditch or conduit for arresting the heavier particles, sand, and silt carried by the water. Means for removing such material may be included.

Saprophyte *(Botany)*—A plant which grows on and derives its nourishment from dead plants or from decaying vegetable matter. Many fungi and bacteria and a few higher plants such as Indian Pipe are Saprophytes. Contrast with *Parasite.*

Saturation *(Hydraulics)*—The condition existing when all interstices of the soil are filled with water.

Sausage Dam—A dam of loose rock wrapped with wire where the resulting cylindrical bundles are laid in a horizontal or vertical position.

Saw Timber—Trees of a size and quality suitable for sawing into lumber.

Scale *(Forestry)*—(1) To estimate the content of sound wood in a log or group of logs, using a given log rule, such as Doyle-Scribner, International. (2) The estimated content of a log or group of logs. *Net Scale* is the scale after deduction for defects.

Scalping—Spot removal of sod or other vegetation before planting tree seedlings.

Scarify—To abrade, scratch or modify the surface; for example, to scratch the impervious seed coat of hard seed, or to break the surface of the soil with a narrow-bladed implement.

Scour—To abrade and wear away. Used to describe the wearing away of terrace or diversion channels or stream beds.

Scouring Sluice—An opening in a dam controlled by a gate through which the accumulated silt, sand, and gravel may be ejected.

Scrub—Stunted trees or brush often in dense stand.

Second-Foot—A unit of measure of the volume of water flow; a cubic foot per second. Abbr. *c.f.s.*

Second-Foot Day—An abbreviation for cubic foot per second for one day (24 hrs.). Equivalent to 86,400 cu. ft.; 1.983471 acre feet; 643,317 gallons; or run-off of .0372 inch from one square mile.

Second-Growth Forest—A forest which comes up after removal of the old stand by cutting, fire, or other cause. Also, the smaller trees left after the clear-cutting of all merchantable trees. Contrast with *Virgin Forest.*

Sedge—A member of the botanical family *Cyperaceae*, resembling the grasses but with the stems more or less triangular and usually solid, leaves three ranked and the leaf sheaths rarely split. Generally inferior to the grasses for forage. (Term sometimes erroneously applied to grasses; for example, some members of the genus *Andropogon* called "broomsedge.")

Sedimentary Rock—Rock derived from the deposition of sediments; examples, sandstone, shale and limestone. Syn. *Clastic Rock.*

Seedbed—The upper portion of the soil prepared by natural or artificial means to promote the germination of seed and the growth of seedlings.

Seedling—A plant grown from seed. In forest nursery practice, a tree which has not been transplanted in the nursery. In natural forest reproduction, a tree from seed, less than 3 feet in height.

Seed Purity—The percentage of one principal species in harvested seed excluding other species, weeds and foreign matter.

Seed Tree—A tree intentionally left standing at the time of cutting a forest, to produce seed for natural seeding of the surrounding area.

Seepage—(1) Water escaping through or emerging from the ground along an extensive line or surface as contrasted with a spring where the water emerges from a localized spot. (2) The process by which water percolates through the soil.

Selective Cutting ***(Forestry)***—A system of cutting in which single trees, usually the largest, or small groups of such trees, are removed and reproduction secured under the remaining stand and in the openings. Contrast with *Clear Cutting.* Also see *Harvest Cutting; Improvement Cutting.*

Selective Grazing—The tendency for livestock and other grazing animals to graze certain plants in preference to others. As a result, certain species may be eradicated while other important species remain virtually untouched. See *Palatability; Unpalatable.*

Self-Mulching Soil—A soil with the surface layer so well aggregated or in such physical condition that it does not crust and seal under rain impact.

Self-Pruning—The natural death and fall of branches, especially the lower branches, from live plants due to causes such as light and food deficiencies, decay, insect attack, snow, and ice.

Semiarid—A term applied to regions or climates where moisture is normally greater than under arid conditions but still definitely limits the growth of most crops. Dry-land farming methods or irrigation generally are required for crop production. The upper limit of average annual precipitation in the cool semiarid regions is as low as 15 inches, whereas in tropical regions it is as high as 45 or 50 inches. Contrast with *Arid.*

Separate, Soil—A size group of individual, dispersed soil particles, as sand, silt, or clay.

Settling Basin—An enlargement in a stream to permit the settling of debris carried in suspension; a form of sand trap.

Sharp-Crested Weir—A notch cut in a relatively thin plate, and having a sharp edge on the upstream side of the crest.

Sheep Month—The amount of forage or feed necessary to support and maintain a mature sheep or an ewe and its suckling lamb for 30 days. Commonly figured as one-fifth of a cow month.

Sheet Erosion—The removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and run-off water. Contrast with *Gully Erosion; Rill Erosion.*

Sheet Piling—A diaphragm made up of meshing or interlocking members of wood, steel, concrete or other material, driven individually. It may be used to form an obstruction to percolation, prevent movement of material, stabilize foundations, and build coffer dams.

Shelterbelt—An extended windbreak of living trees and shrubs established and maintained for protection of farm lands over an area larger than a single farm. Includes *Basic Shelterbelts* which serve as bulwarks in the protection plan, and narrow *Intermediate Shelterbelts* supplementing the basic shelterbelts. See *Windbreak.*

Shore Erosion—Removal of sand, soil, or rock from the land area adjacent to oceans, seas, lakes, or ponds due to the action of water or wind.

Shrub—A woody perennial plant differing from a perennial herb by its more woody stems, and from a tree by its low growth and habit of branching from the base. There is no hard and fast line between herbs and shrubs or between shrubs and trees; all possible integradations occur.

Side-Channel Spillway—See Lateral-Flow Spillway.

Side Slopes ***(Engineering)***—The slope of the sides of a canal, dam, or embankment. It is customary to name the horizontal distance first as 1.5 to 1, (or frequently, 1½:1) meaning a horizontal distance of 1.5 feet to 1 foot vertical.

Significant ***(Statistics)***—A term applied to differences, correlations, etc., to indicate that probably they are not due to chance alone. Significant ordinarily indicates a probability of not less than 95% while highly significant indicates a probability of not less than 99%.

Silage—A crop which has been preserved in a moist succulent condition by partial fermentation in a tight receptacle. The chief silage crops are corn, sorghum and various legumes and grasses.

Silt—(1) Small mineral soil grains intermediate between clay and sand; 0.05 to 0.002 mm. in diameter according to U. S. Department of Agriculture standards; 0.02 to 0.002 mm. in diameter according to the International System. (2) Waterborne sediment with diameters of individual grains approaching that of silt. (3) Soil material containing 80% or more silt and less than 12% clay.

Silt Basin—See Settling Basin.

Silting—The deposition of water-borne sediments in lakes, reservoirs, stream channels, or overflow areas. It is caused by a decrease in the velocity of stream flow and a corresponding reduction in the amount and size of solid material which can be carried in suspension.

Siphon ***(Hydraulics)***—A closed conduit, a part of which rises above the hydraulic grade line. It utilizes atmospheric pressure to cause the flow of water through it.

Site ***(Ecology)***—(1) An area, considered as to its ecological factors with reference to capacity to produce vegetation; the combination of biotic, climatic, and soil conditions of an area. (2) An area sufficiently uniform in soil, climate and natural biotic conditions to produce a particular climax vegetation.

Site Index ***(Forestry)***—A numerical expression of the quality or timber productivity of forest land, as determined by the rate of growth in height of one or more tree species present; for example, the average height attained by dominant and codominant trees, in fully stocked stands, at the age of 50 years.

Skimming—Diverting surface water by shallow overflow to avoid diverting sand, silt, or other debris carried as bottom load.

Slash—The branches, bark, tops, cull logs and broken or uprooted trees on the ground after logging.

Slashing—Forest area which has been logged off and upon which the slash remains.

Slicks—A local term used to describe alkali spots. Syn. *Slick Spots.*

Slip ***(Erosion)***—The down hill movement of a mass of soil under wet or saturated conditions. The movement is only a short distance and the soil mass stays relatively intact. A form of landslide.

Slope, Land—The inclination of the land surface from the horizontal. Usually expressed in percent for soil conservation work. Can be expressed in degrees.

$$\text{Percent slope} = \frac{\text{Vertical distance}}{\text{horizontal distance}} \times 100$$

Sluice—(1) A conduit for carrying water at high velocity; an opening in a structure for passing debris. (2) To cause water to flow at high velocities for ejecting debris.

Slush Ice—See Frazil Ice.

Snow Course—A course laid out and permanently marked on the drainage area of a stream, along which the snow is sampled at appropriate times to determine its depth and density for the purpose of forecasting subsequent run-off.

Snow Density—The water content of snow expressed as a percentage by volume. In snow surveys, it is the ratio of the scale reading (inches of water) to the length of the snow core, in inches.

Snowfence—A fence of slat and wire or other material used in winter to intercept drifting snow, thus protecting roads, railways, and other areas from snow drifts. Also used to impound snow where melting in place adds to soil moisture.

Snowhedge—A planting of shrubs or other plants to intercept drifting snow.

Snow Sample—A core taken from the snow mantle on a snow course, from which the depth and density may be determined.

Snow Sampler—An outfit consisting essentially of light jointed tubes for taking snow samples and a spring scale graduated to read directly the corresponding depth of water contained in a snow sample.

Snow Surveys—A set of measurements of the depth and density of snow, usually made to determine the water stored on a drainage basin in the form of snow, as a means of forecasting the subsequent run-off.

Sod—A surface layer of soil matted or held together by roots, rhizomes and stolons of grasses and other herbs.

Sod Grass—A grass which normally forms a sod or turf, with individual plants spreading by means of stolons or rhizomes; for example, Kentucky bluegrass, Bermuda grass, and bromegrass. Contrast with *Bunch Grass.*

Sod Strips—Narrow bands of grass or other close-rooted crop, placed across a channel to spread and retard the flow of water; strips of sod left in a natural waterway to prevent erosion.

Soil—Soil is a natural body developed from weathered minerals and decaying organic matter, covering the earth in a thin layer. It is a natural medium on the surface of the earth in which plants may grow .

Soil Building—Increasing the productive capacity of soil by appropriate fertilization, growth of soil-building plants, and good management.

Soil Classification—The systematic grouping of soils based on profile characteristics such as thickness, color, and structure of the different horizons, drainage, and parent material. Also see *Soil Series; Soil Type.*

Soil Conservation—The preservation of soil against deterioration and loss by using it within its capabilities, and applying the conservation practices needed for its protection and improvement. More specifically, soil conservation consists of using the land within the limits of economic practicability while safeguarding it against impoverishment or depletion by erosion, deposition, exhaustion of plant nutrients (through leaching, excessive cropping or overgrazing), accumulation of toxic salts, burning, waterlogging (inadequate drainage), improper cultivation or any type of improper use or failure to protect the land from soil loss or impairment of productiveness.

Soil Conservation District—An organization created under state law for developing and carrying out a program of soil and water conservation within its geographic boundaries. In most states a soil conservation district is a legal subdivision of the State Government, autonomously controlled, with public powers.

Soil Conservation Farm Plan—See Farm Conservation Plan.

Soil Conservation Survey—A record on a map or aerial photograph of the physical land features that are significant in determining land capability and in recommending land use and soil conservation practices. The features include the kind of soil, steepness of slope, type and degree of soil erosion, and overflow hazards or salinity if they are present. Used without modifying terms such as general or reconnaissance, a soil conservation survey is one that shows the physical land features in enough detail and with enough precision to furnish basic land information for planning land use and conservation measures for the specific land on a farm or ranch. General surveys of this kind are made also, and are called *Reconnaissance Soil Conservation Surveys.*

Soil Conserving Crops—Crops that prevent or retard erosion and maintain or replenish rather than deplete soil organic matter. Grasses and legumes that are cut for hay and produce considerable aftermath generally can be regarded as soil conserving crops.

Soil Depleting Crops—Crops that under the usual management tend to deplete nutrients and organic matter in the soil, and to permit deterioration of soil structure. Most clean-tilled crops are soil-depleting if the entire plant is removed. Grain crops are soil-depleting if both grain and straw are removed.

Soil Erosion—The detachment and movement of soil

from the land surface by wind or running water, including normal soil erosion and accelerated erosion. See *Gully Erosion; Rill Erosion; Sheet Erosion; Splash Erosion; Wind Erosion.*

Soil Granule—A cluster of soil particles behaving as a unit in soil structure. See *Granular Soil.*

Soil Horizon—A layer of soil approximately parallel to the land surface with observable characteristics that have been produced through the operation of soil building processes. Each horizon differs in one or more characteristic from the one above or below. The letters A, B and C are used to designate soil horizons.

A. The A horizon is the upper part. It consists of mineral layers of maximum organic accumulation; or layers from which clay minerals, iron and aluminum have been lost; or both. (The loose surface organic matter in unplowed areas is not strictly part of the A horizon.

B. The B horizon lies under the A. It consists of weathered material with an accumulation of clay, iron or aluminum; or with more or less blocky or prismatic structure; or both. Usually it is more strongly colored than the horizon above or below.

C. The C horizon, under the B, is the layer of unconsolidated, weathered parent material.

In addition the letter D is used to designate any such stratum under the soil as hard rock, sand or clay that is not parent material, but which may have some significance to the overlying soil.

Note: Not all these horizons are present in all soils.

Soil Improvement—The process of making soil more fertile and productive. This involves the use of good soil management practices such as liming, manuring, fertilizing, and rotating crops.

Soil Management—The act or art of using soil for the production of crops. Continuous, profitable production involves the maintenance of the physical structure of the soil, the organic matter, the available nutrients, the biological activities, and the conservation of soil and water.

Soil Mapping Unit—See Land Mapping Unit.

Soil Productivity—(1) The property of a soil which permits variable growth of plants due to the collective influence of variable chemical, physical and biological conditions. (2) The ability of a soil to produce crops under existing conditions of climate and management.

Soil Profile—A vertical section of the soil from the surface through all its horizons into the parent material. See *Soil Horizon.*

Soil Saving Dam—A dam of earth or other material placed across a gully or other watercourse to impound silt and surface run-off, and to control erosion. Term sometimes used only when referring to the larger, permanent types of dams, as contrasted with check dams.

Soil Saving Dike—An earth dike constructed on the lower end of an irrigated field, usually with an adjustable outlet, built for the purpose of holding sediment on the field.

Soil Series—A group of soils closely similar in all respects except the texture of the surface soil. The soil series expresses profile characteristics such as the color, structure, and thickness of horizons, type of parent material and drainage.

Soil Survey—The systematic examination, mapping, describing, and classification of soils in an area.

Soil Type—A subdivision of the soil series based on the texture of the surface soil. A soil which throughout the full extent of its occurrence has relatively uniform profile characteristics, and relatively uniform texture of the surface soil. For example, Cecil sandy loam and Cecil clay loam are two soil types belonging to the Cecil series.

Soil Water ***(Hydraulics)***—Water in the soil root zone; water in the zone of aeration above the intermediate water.

Solum—The true soil developed by soil building forces. Usually this is the A and B horizon, or the upper part of the soil profile above the parent material.

Specific Gravity ***(Soils)***—The ratio of the weight of a given volume of soil (volume occupied by solid phase, pore space excluded) to the weight of an equal volume of water. It varies chiefly with the amount of organic matter present in the soil. The average specific gravity for tilled surface soil is about 2.65. Contrast with *Volume Weight.*

Specific Yield ***(Hydraulics)***—The amount of water which a rock or earth will yield after being saturated and allowed to drain under specified conditions. It is expressed as percent of volume.

Spillway—A conduit in or around a dam for the escape of excess water.

Splash Erosion—A form of soil erosion resulting from soil splash caused by the impact of falling rain drops.

Spoilbank—A pile of soil, subsoil, rock or other material excavated from a drainage ditch, pond, or other cut.

Spot Plant ***(Forestry)***—To plant in small open areas between established stands. Also see *Interplanting.*

Spreader—A device for distributing water uniformly in or from a channel.

Spreader Strip—A relatively permanent contour strip, of variable width, planted to a sod or erosion resistant crop. Its purpose is to slow down and fan out the run-off from the cultivated land above the strip.

Sprigging—The planting of a portion of the stem and root of grass.

Sprinkler Irrigation—Irrigation by means of spray from pipes or pipe projections above the soil surface.

Spur Dike—A dike of rock or other material built from the bank into the channel for bank protection or for channel improvement.

Spur Terrace—A short terrace used to collect or divert run-off.

Square Check Irrigation—A method of check irrigation using square or rectangular basins to confine irrigation water. See *Check Irrigation.*

Square Foot Method—A research technique in range surveys for determining average density and composition of range vegetation, by means of systematically located plots on which the herbage of each species is estimated individually in square feet of ground covered. Syn. *Square Foot Density Method.*

Stabilized Grade—The slope of a channel at which neither erosion nor silting occurs.

Stage ***(Hydraulics)***—Elevation of a water surface above any chosen datum plane, often above an established low-water plane; gage height.

Staking—Determining the location for the placing of wood or metal stakes as markers to be used in building structures like terraces, ponds, and drains. For example, staking a terrace line consists of placing stakes along the course of a terrace to be built; staking a drainage ditch includes marking the location, and also the depth of the ditch to be dug.

Stand—The number of uniformly distributed plants per unit area. A good or full stand refers to the optimum number of plants per unit area, while a medium, fair, or poor stand has less than the optimum number. In forestry, the stand refers to the kind as well as number of trees per unit area. Thus, a forest may be described, for example, as a pure stand, pine stand, hardwood stand, or mixed pine-oak stand.

State Soil Conservation Committee, Commission, or Board—The state agency, established by state soil conservation district enabling legislation, to assist with the administration of the provisions of the state soil conservation districts law.

Static Head—The total head without deduction for velocity head or losses; for example, the difference in elevation of headwater and tail water of a power plant.

Steady Flow—A constant flow; that is, the quantity does not change with time.

Stilling Basin—An open structure or excavation at the foot of a waterfall or rapids to reduce the velocity and turbulence of the descending current.

Stilling Well—A pipe or other compartment with closed sides and bottom except for comparatively small inlets connecting the well with a larger main body of water. Its purpose is to still or dampen waves or surges while permitting the water level in the well to rise and fall with major fluctuations of the main body.

Stock Pond—See Farm Pond; Tank, Earth.

Stock Trail—Any passageway constructed or cleared to facilitate the movement of livestock and make more efficient use of the forage.

Stockwater Development—The development of new or improved sources of stockwater supplies, such as wells, springs, and ponds, together with storage and delivery systems.

Stolon—A horizontal stem which grows along the surface of the soil and roots at the nodes. White clover has stolons.

Storm—In general, a disturbance of the ordinary average conditions of the atmosphere. The term may be qualified to emphasize a particular part of the meteorological disturbance such as windstorm, rainstorm, or thunderstorm.

Stover—The dried, cured stems and leaves of tall, coarse grain crops such as corn and sorghum, after the grain has been removed. Contrast with *Fodder; Hay.*

Stream Banks—The usual boundaries (not flood boundaries) of a stream channel. Right and left banks are named facing downstream.

Stream-Bank Erosion—Removal of material, usually the soil and the underlying alluvium, along the banks due to the current action of the stream.

Stream-Bank Erosion Control—Vegetative or mechanical control of erodible stream banks. It includes such measures to prevent streambanks from caving or sloughing as jetties, revetments, rip-rap fencing, and plantings necessary for permanent protection.

Stream-Bed Erosion—The scouring of material from the water channel and the cutting of the banks by running water. The cutting of the banks is also known as *Stream-Bank Erosion.*

Stream Gaging—The quantitative estimation of stream flow using current meters, weirs, or other devices at selected locations.

Strip Cropping—Growing crops in a systematical arrangement of strips or bands to serve as vegetative barriers to wind and water erosion. See *Buffer Strips; Contour Strip Cropping; Correction Strip; Field Strip Cropping; Filter Strip; Sod Strips; Spreader Strip; Strip Sodding, Contour; Wind Strip Cropping.*

Strip Sodding, Contour—The use of strips of sod on the contour, alternating with spaces which are not sodded. See *Sod Strips.*

Strip Survey—A survey employing continuous narrow strips as sampling units. Strips, commonly ½, 1, or 2-chains wide, are run across the area to be surveyed.

Structure, Soil—The arrangement of soil particles, either single grain or in aggregates, that make up the soil mass. The structure may refer to the natural arrangement of the soil when in place and undisturbed or to the the soil at any degree of disturbance. The principal types of soil structure (aggregates) are platy, prismatic, columnar, blocky, nuciform, granular and crumb. The aggregates in these structure types vary in size and degree of stability. Structure is one of the important characteristics which determines the erodibility of soils.

Stubble—The basal portion of plants remaining after the top portion has been harvested; also the portion of the plants, principally grasses, remaining after current grazing is completed.

Stubble Crops—(1) Crops developed from the stubble of the previous season. (2) Crops sowed on grain stubble after harvest for turning under the following spring.

Stubble Mulch—A protective cover provided by leaving plant residues of any previous crop as a mulch on the soil surface when preparing for and planting the following crop.

Stumpage—The value of timber as it stands uncut in the woods; the uncut timber.

Subhumid—A term applied to regions or climates where moisture is normally less than under humid conditions but still sufficient for the production of many agricultural crops without irrigation or dry-land farming. Natural vegetation is mostly tall grasses. The annual rainfall varies from 20 inches in cool regions to as high as 60 inches in hot areas. Contrast with *Humid.*

Subirrigation—Irrigation by controlling the water table to raise it into or nearly to the root zone. See *Subsurface Drainage Check.*

Submerged Weir—A weir which in use has the tail-water level higher than the weir crest. Contrast with *Free Weir.*

Subsoil—Roughly, that part of the solum under the topsoil; in soils not having clearly differentiated layers, the soil under the topsoil to a depth of about five feet.

Subsoiling—Tillage of the subsoil or soil horizon below the normal plow depth. Sometimes referred to as *Chiseling.* The intended purpose is either to break or shatter a hardpan which has been impeding internal soil drainage or to shatter and treat a claypan layer that has been limiting the root depth of the soil.

Substratum—An indefinite term for the C horizon of a soil; the layer below the land surface. Also see *Underlying Stratum.*

Subsurface Drainage Check—A gate or other structure placed in a deep drainage ditch or covered drain whereby the drainage discharge can be controlled to maintain a constant ground-water level for subirrigation.

Subsurface Irrigation—Irrigation by means of underground porous tile or its equivalent.

Subsurface Tillage—Tillage with specialized equipment which thoroughly loosens and prepares a seedbed but does not invert the surface residual mulch. See *Mulch Tillage.*

Subwatershed—A watershed subdivision of unspecified size that forms a convenient natural unit for planning and installing soil and water conservation measures, particularly those involving water detention, channel stabilization, and sediment control. See *Watershed (2).*

Succession—The progressive development of vegetation toward its highest ecological expression, the climax; replacement of one plant community by another. The initial growth of plants on newly formed soils or on soil surfaces which are exposed for the first time and have never borne vegetation is called the *Primary Succession.*

Summer Fallow—The tillage of uncropped land during the summer in order to control weeds and store moisture in the soil for the growth of a later crop. A practice common in semi-arid regions, where the annual precipitation is insufficient to produce a crop every year, especially before planting winter grains.

Supplemental Irrigation—The watering of crops in regions where normal rainfall ordinarily supplies most of the moisture. It is used during dry periods to prevent retardation of growth.

Supplemental Pasture—Additional pasture for use in adverse weather conditions, usually annual forage crops for dry periods or winter time. See *Temporary Pasture.*

Suppressed Tree—A tree with growth is seriously retarded by crowding and shading.

Suppressed Weir—A measuring weir with the sides of the notch flush with the channel, thus eliminating end contractions of the overflowing water.

Surface Profile *(Hydraulics)*—The longitudinal profile assumed by the surface of a stream of water flowing in an open channel; the hydraulic grade line.

Surface Soil—The upper part of a cultivated soil commonly stirred by the plow or other tillage implements; or an equivalent depth, 5 to 8 inches, in non-arable soils.

Swamp—A land area with excess water much of the year and a dense growth of native vegetation, including trees; for example, cypress and mangrove swamps of the southern United States.

T

Tailwater—The water just downstream from a structure.

Talus—An accumulation of broken rock at the base of a cliff or steep mountain. Results from gravity acting on fragments of rock broken off above.

Tank, Earth—A structure formed by an excavation and an earthen dam across a drainage for impounding drinking water for livestock. Syn. *Livestock Reservoir; Stock Pond.*

Tap Root System—A plant root system dominated by a single large "taproot," normally growing straight down, from which most or all of the smaller roots spread out laterally. Alfalfa and carrot have taproots. Contrast with *Fibrous Root System.*

Temporary Pasture—A pasture designed to provide grazing for only a short period, usually consisting of annual plants. See *Supplemental Pasture.*

Terrace—An embankment or ridge of earth constructed across a slope to control run-off and minimize soil erosion. Bench terraces and ridge terraces are the two general types. See *Bench Terrace; Ridge Terrace.* Also see *Broad-Base Terrace; Diversion; Drainage Terrace; Graded Terrace; Level Terrace; Mangum Terrace; Narrow-Base Terrace; Nichols Terrace; Spur Terrace.*

Terrace Height—The difference in elevation between the bottom of the terrace channel and the top of the terrace ridge at adjacent points.

Terrace Interval—Measured either as a vertical or horizontal distance between corresponding points on two adjacent terraces. The vertical interval (difference in elevation between stake lines) is used almost exclusively in staking terrace lines for construction. For the top or first terrace it is measured between the top of the hill and the center of the terrace.

Terrace Outlet Channel—The channel into which the flow from one or more terraces is discharged and

conveyed from the field. It is generally protected from erosion by a dense cover of perennial grass.

Terrace System—A complete series of terraces occupying a slope and discharging run-off into one or more outlet channels.

Terrace Width—The combined width of the terrace channel and ridge as measured horizontally from the high water line on the upper edge of the channel to the foot of the lower slope of the terrace ridge.

Texture, Soil—The relative proportions of various sized mineral particles, or soil separates, in the soil. Clay soils are said to be fine or heavy textured, loams are medium textured, and sandy or gravelly soils are coarse or light textured. In the laboratory, texture is determined by mechanical analysis. In the field, by the feel when the moist soil is rubbed between the thumb and fingers.

Thinning ***(Forestry)***—A cutting made in immature stands after the sapling stage for the purpose of increasing the rate of growth of those trees which are left.

Threshold Velocity ***(Wind Erosion)***—The minimum velocity at which wind will begin moving particles of sand or other soil material.

Tidal Marsh—Low flat marshlands traversed by interlacing channels and tidal sloughs and usually inundated by high tides. Vegetation usually consists of rushes, grasses, and a few other low-growing salt-tolerant plants.

Tide Gate—A swinging gate on the outside of a drainage conduit from a diked field below high tide level. The gate excludes water at high tide and permits drainage at low tide.

Tile, Drain—Pipe made of burned clay, concrete or similar material, in short lengths, usually laid with open joints to collect and carry excess water from the soil.

Tillage—Working the soil for the purpose of providing more favorable conditions for plant growth. Most common tillage operations are plowing, harrowing, and cultivating.

Tiller—A branch which is usually erect or semi-erect and which arises from a bud in the axils of leaves at the base of a plant. Wheat and other annual and perennial grasses increase in circumference by tillers.

Tilth, Soil—The physical condition of the soil in its relation to plant growth, especially soil structure. Good tilth refers to the friable state, and is associated with high non-capillary porosity and stable granular structure. A soil in poor tilth is non-friable, hard, non-aggregated, and difficult to till.

Tilting Gate—A gate hinged at the top or bottom and counterbalanced by weights, automatically opening or closing with the change in head.

Toe ***(Engineering)***—The lowest downstream edge of a dam or structure.

Topsoil—A distinguishable layer at the surface of the soil, often 6 or 7 inches in thickness. In dark-colored soils, the surface layer or layers distinctly higher in organic matter than the material below. In many light-colored soils, the layers that lie over material of heavier texture and more pronounced structure, provided such material occurs within about 15 inches of the surface. In uniform soil material, the soil to plow depth. The thickness of the original topsoil, before accelerated erosion, is used as a standard against which to estimate the degree of accelerated erosion.

Total Digestible Nutrients—A standard evaluation of the digestibility of a particular feed for livestock—includes all the digestible organic nutrients: protein, fiber, nitrogen-free extract and fat (the latter being multiplied by 2.25 because its energy value for animals is approximately 2.25 times that of protein or carbohydrates). The percentage of Total Digestible Nutrients, therefore, represents the approximate heat or energy value of the feed. Abbr. *T.D.N.*

Toxic Salt, Reduction of—Decreasing the concentration of toxic salts in soils by leaching, irrigation, or addition of soil amendments.

Trace Element—See Essential Elemetn.

Transect—A cross section of an area used as a sample for recording, mapping or studying the vegetation and its use; a transect may be a series of plots, a belt or strip, or merely a line.

Transpiration—The discharge of water as vapor into the atmosphere by the leaves and stems of living plants.

Transplant ***(Forestry)***—A seedling which has been transplanted one or more times in the nursery.

Transportation ***(Soil Erosion)***—The movement of detached soil material across the land surface or through the air. May be accomplished by running water, wind or gravity. See *Detachment*.

Tree—A woody plant that reaches a height of at least 8 to 10 feet, has a single stem and a definite crown shape. (There is no clear-cut distinction between trees and shrubs, and some plants, such as sumac and willows, may grow as either trees or shrubs.)

Tree Planting—Planting trees, shrubs, vines, and cuttings of same to prevent soil loss and excessive run-off and to produce wood products. It includes plantings for controlling gullies, sand dunes, protecting banks, windbreaks, under-planting, or inter-planting of existing woodlands, and field planting.

Truncated Soil Profile—Soil profile which has been cut down by accelerated erosion or by mechanical means. A profile may have lost part or all of the A and sometimes the B horizon leaving as soil only the undeveloped parent material or C horizon. Comparison of eroded soil profile with virgin profile of the same area, soil type, and slope conditions, indicates degree of truncation.

Tufting—The planting of sod or grasses in tufts or small bunches.

Turbine Pump, Deep Well—A vertical multistage centrifugal pump with impeller casings having vanes which economically convert the velocity

head to pressure head, and is designed to be installed in the well casing below the water table.

Turbulent Flow *(Hydraulics)*—A type of flow in which any particle may move in any direction with respect to any other particle and not in a fixed or regular path. The water is agitated by cross currents and eddies. The head loss is approximately proportional to the second power of the velocity. Syn. *Sinuous Flow; Tortuous Flow.*

Turbulent Velocity *(Hydraulics)*—That velocity above which, in a particular conduit, turbulent flow will always exist, and below which the flow may be either turbulent or laminar, depending on circumstances.

Turnaway—See Headland.

Two-Stage Dam—A dam having two distinct drops.

U

Undercutting *(Erosion)*—Removal of material at the base of a steep slope or cliff by falling water, a stream, wind erosion, or wave action. This removal steepens the slope or produces an overhanging cliff.

Underflow—Movement of water through a pervious subsurface stratum; the flow of percolating water; the flow of water under ice, or under a structure.

Undergrazing—An intensity of grazing in which the forage available for consumption under a system of conservation range or pasture management is not used to best advantage. Contrast with *Overgrazing.*

Undergrowth *(Forestry)* — Seedlings, shoots, and small saplings under an existing stand of trees.

Underlying Stratum *(Soils)*—Any stratum underneath the soil, such as hard rock or a layer of clay or sand, that is not parent material. It may or may not affect the overlying soil.

Underplant—To plant young trees or sow seeds under an existing stand of trees.

Understocking *(Range Management)*—A condition where a smaller number of animals than could be adequately accommodated by the forage produced grazes on a given range in a given season. Contrast with *Overstocking; Proper Stocking.*

Understory—That portion of the trees in a forest below the upper crown cover. Syn. *Underwood.* Contrast with *Overstory.*

Unhulled Seed—Any seed normally covered by a hull, that is, by bracts or other coating, and from which the hull has not been removed.

Uniform Flow *(Hydraulics)*—A flow in which the mean velocity is constant. Uniform Flow is also referred to as *Steady Uniform Flow.* It is an ideal condition that can only be approximated in fact. If the velocity of the constant discharge varies, the flow is defined as *Steady Non-uniform.*

Unpalatable—A term applied to feed, forage or individual plant species that are not well-liked and therefore not eaten readily by domestic animals.

Uplift *(Hydraulics)*—The upward pressure of water on the base of a structure.

Use, Actual *(Range)*—The total number of livestock that have actually grazed on a range and the length of time that they have used it, usually expressed in animal-unit months, cow months, or sheep months.

Use, Common *(Range)*—Grazing a given range by more than one kind of livestock within the same grazing year.

Use, Community *(Range)*—Grazing on an area restricted to the livestock belonging to a specified local group of owners.

Use, Dual *(Range)*—The use of a given range by more than one kind of livestock at the same time.

Use, Proper *(Range)*—Grazing a range to the best advantage, considering all factors. These include maintaining optimum vigor of forage plants by grazing so as to prevent serious injury to the forage or to the soils upon which the plants grow.

V

Variable Grade Channel—A channel having a variable slope. the slope generally decreasing as the distance from the outlet increases. For example, a channel 1,200 feet long may be built in four 300-foot sections each having different grades, the outlet end having 0.25 foot fall per 100 feet; the next section, 0.20; the third, 0.15; and the fourth section, 0.10 foot per 100 feet. In comparison, a uniform grade channel has a constant slope throughout its entire length.

Vegetated Channel—See Grassed Waterway.

Vegetative Practices—Any method of effecting soil and moisture conservation by the use of vegetation.

Velocity Head *(Hydraulics)*—The distance a body must fall freely in a vacuum under the force of gravity to acquire the velocity it possesses.

$h_v = \frac{V^2}{2g}$ where h_v is velocity head; V is the mean velocity of the flowing water and g the acceleration due to gravity.

Venturi Flume—A type of measuring flume having a contracted throat section at which there occurs an increase in velocity and a decrease in the depth of flow. The flow through the throat section is at a velocity less than Belanger's critical velocity. See *Parshall Measuring Flume.*

Venturi Meter—A proprietary device for measuring the flow of fluids through pipes. It consists essentially of a Venturi tube and a special form of flow-registering device.

Venturi Tube—A closed conduit which is gradually contracted to a throat, causing a reduction of pressure head by which the velocity through the throat may be determined.

Virgin Forest—A forest essentially uninfluenced by human activity.

Volume Weight *(Soils)*—A figure indicating the number of times heavier a dry soil, including the soil pore space. is than an equal volume of water. Depends on the true specific gravity and porosity of the soil. Volume weights range from as low as 1.0 to as high as 2.0. Syn. *Apparent Specific Gravity; Bulk Density.* Contrast with *Specific Gravity.*

W

Wash—A gully. In southwestern United States, the dry bed of an intermittent stream, sometimes at the bottom of a canyon.

Wasteway—The channel required to convey water discharged into it from a spillway, escape, or sluice; a spillway.

Water Conservation—The physical control, protection, management, and use of water resources in such a way as to maintain crop, grazing and forest lands, vegetal cover, wildlife and wildlife habitat for maximum sustained benefits to people, agriculture, industry, commerce, and other segments of the national economy.

Water Control ***(Soil and Water Conservation)***—The physical control of water by such measures as conservation practices on the land, channel improvements, and installation of structures for water retardation and sediment detention. (Water control as defined here does not refer to legal control or water rights.)

Water Cushion—A pool of water maintained to break the impact of water overflowing a dam, chute, or other spillway structure.

Water Demand—A schedule of the water requirements for a particular purpose, as for irrigation, power, municipal supply, plant transpiration or storage.

Water Disposal System—The complete system for removing excess water from land with minimum erosion. For sloping land it may include a terrace system, terrace outlet channels, dams, and grassed waterways. For level land it may include only surface drains or both surface and subsurface drains.

Water Level (Stage) Recorder — See Recording Gages.

Water-Logged — A condition of lands where the ground water stands at a level that is detrimental to plants. It may result from over-irrigation, seepage, or inadequate drainage.

Water Requirement ***(Plant Physiology)***—In a strict sense, the ratio of the number of units of water absorbed by the plant during the growing season to the number of units of dry matter produced by the plant during that time. More generally, the amount of water lost through transpiration during the growing season, since the amount retained in the plant is very small compared to the amount evaporated from it. Water requirement varies with climatic conditions, soil fertility and soil moisture.

Water Resources—The supply of water in a given area or watershed. Usually interpreted in terms of availability of surface or underground water.

Water Rights—The legal rights to the use of water. They consist of riparian rights, and those acquired by appropriation and prescription. *Riparian Rights* are those which a riparian owner has to the use of the stream or water by which his land is bounded or traversed. *Appropriative Rights* are those acquired by an individual to the exclusive use of water, based strictly on priority of appropriation and application of the water to beneficial use, and without limitation of the place of use to riparian land. *Prescriptive Rights* are those to which legal title is acquired by long possession and use without protest of other parties.

Water Spreading—The application of water to lands for the purpose of increasing the growth of natural vegetation or to store it in the ground for subsequent withdrawal by pumps for irrigation. Also see *Winter Irrigation.*

Water Table—The upper surface of free ground water in a zone of saturation except when separated from an underlying body of ground-water by unsaturated material.

Water Table, Perched—The upper surface of a body of free ground water in a zone of saturation, separated by unsaturated material from an underlying body of ground water in a different zone of saturation. See *Perched Water.*

Watershed—(1) The total land area, regardless of size, above a given point on a waterway that contributes run-off water to the flow at that point. (2) A major drainage-area subdivision of a drainage basin. On the basis of this concept the United States is generally divided into some 150 watersheds such as the Cheyenne, Delaware, Pecos, Pee Dee, Munkingum, and Willamette. See *Subwatershed* and *Minor Watershed* which are successive subdivisions of this concept of Watershed.

Watershed Management—The use of watershed lands in accordance with such predetermined objectives such as the control of erosion, stream flow, silting, floods, and water, forage or timber yield.

Watershed Planning—Planning the use and treatment of land and water which will most nearly meet all the objectives of soil and water conservation from the standpoint of both the individual farms and all the residents of the watershed.

Waterway—A natural course for the flow of water. Also see *Farm Waterway.*

Weather—The state of the atmosphere at any given time with respect to temperature, humidity, cloudiness, precipitation, wind velocity and barometric pressure. Contrast with *Climate.*

Weathering—The physical and chemical disintegration and decomposition of rocks and minerals.

Weed—An unwanted competitive plant in fields, gardens, orchards, pastures, ranges, and forests.

Weed Tree—An undesirable species of tree which interferes with the development of crop trees.

Weep-Holes ***(Engineering)***—Openings left in retaining walls, aprons, linings, or foundations to permit drainage and reduce pressure.

Weight Method ***(Range Management)***—A method of arriving at the volume of forage or herbage on a range by clipping and weighing samples, or by estimating weight on areas of known size.

Weir—A dam across a stream for diverting or for measuring the flow. See *Measuring Weir.*

Weir Notch—The opening in a weir for the passage of water.

Wells ***(Irrigation)***—A bore or shaft extending into an aquifer capable of yielding water for irrigation purposes.

Wetted Perimeter ***(Hydraulics)***—The length of the line of contact between the water and the sides and bottom of a channel, measured perpendicular to the direction of the channel.

Wicket Dam—A movable barrier made of wickets, or shutters, revolving about a central axis.

Wildlife—Undomesticated vertebrate animals considered collectively.

Wildlife Area Management—The protection and development of areas for the benefit of wildlife. Measures used may include planting, fencing, control of grazing and fire, cutting, ditching, water level control, and any other practices that will provide food, cover, and water for wildlife. Includes such areas as marshes, odd areas, fence rows, hedges, gullies, streambanks, borrow pits and water-logged land.

Wildlife Border — A strip of low growing plants (herbaceous plants, shrubs, or both) along edges of woodland, established by planting seeds or plants or developed by release cutting of competing woody plants.

Wildlife Conservation—(1) Reasonable use and management of environmental factors, such as food and cover, such to allow maximum breeding populations and cropping of game and furbearers such as, quail, pheasants, and muskrats. (2) The presentation of rare or vanishing species; example, California condor.

Wildlife Land—(1) Land, whether or not suitable for other uses, used for the main or sole purpose of producing or maintaining wildlife. (2) Land of such character that its only practical use is for wildlife habitat or production.

Wildlife Management—The art of manipulating a habitat and sometimes the animals themselves to control their abundance. See *Fish Pond Management; Game Management; Marsh Management; Odd Areas Management; Pond Management;* and *Wildlife Area Management.*

Wildling—A seedling or young plant that has grown wild, that is, outside a nursery, and has been dug for use as planting stock.

Wilting Coefficient ***(Soils)***—The moisture in percentage of dry weight remaining in the soil when plants reach a condition of permanent wilting. (Plants will not revive when placed in a saturated atmosphere.) Also known as *Wilting Point.*

Windbreak—A barrier of trees and shrubs, usually with three or more rows, to reduce or check the force of the wind. Established for the protection of fields, orchards, feedlots and homesteads. See *Shelterbelt.*

Wind Erosion—The detachment, transportation, and deposition of soil by the action of wind. The removal and redeposition may be in more or less uniform layers or as localized blowouts and dunes.

Wind Strip Cropping—The production of crops in long, relatively narrow strips, placed crosswise of the direction of the prevailing winds without regard to the contour of the land.

Wing Dam—See Spur Dike.

Wing Wall—Side walls of a dam structure extending from head-wall downstream the length of the apron; used to prevent sloughing of banks or channels, and to direct and confine overfall.

Winter Irrigation—The irrigation of lands between growing seasons in order to store water in the soil for subsequent use by plants.

Wire Dam—A dam with the head wall constructed of mesh wire.

Wolf Tree—A tree occupying more space than its value warrants, curtailing better neighbors. A term usually applied to broad-crowned, short-stemmed trees, or to a weed tree of large size, growing for some time, and overtopping others, or taking valuable space.

Woodland—Any land used for the natural growth of trees and shrubs. Woodland includes in addition to what is ordinarily termed "forest" or "forest plantations," shelterbelts, windbreaks, wide hedgerow areas in woodland species for wildlife food or cover, stream and other banks with woodland cover, gullies and roadsides with permanent woodland cover, etc. It also includes the farmland upon which it has been determined woody vegetation is to be established and maintained.

Woodland Management—The management of existing woodlands and plantations that have passed the establishment stage. Includes all measures designed to improve the quality and quantity of woodland growing stock and to maintain litter and herbaceous ground cover for soil and water conservation. Some of these measures are planting, improvement cutting, thinning, pruning, slash disposal, and protection from fire and grazing.

Woodlot—A small tract of woods on a farm; a shady enclosure or grove for livestock.

Z

Zone of Aeration ***(Hydraulics)***—A layer of earth (may be both soil and the underlying strata) not filled, except temporarily, with water under hydrostatic pressure. The interstices contain air and water, except the smaller ones within the capillary fringe may be completely filled with water held by capillary force. The zone of aeration comprises the area where fringe water, intermediate water, and ground water may be found.

Zone of Saturation ***(Hydraulics)***—A layer of the earth (may be both soil and the underlying strata) containing gravitational or free water under hydrostatic pressure.

—THE END

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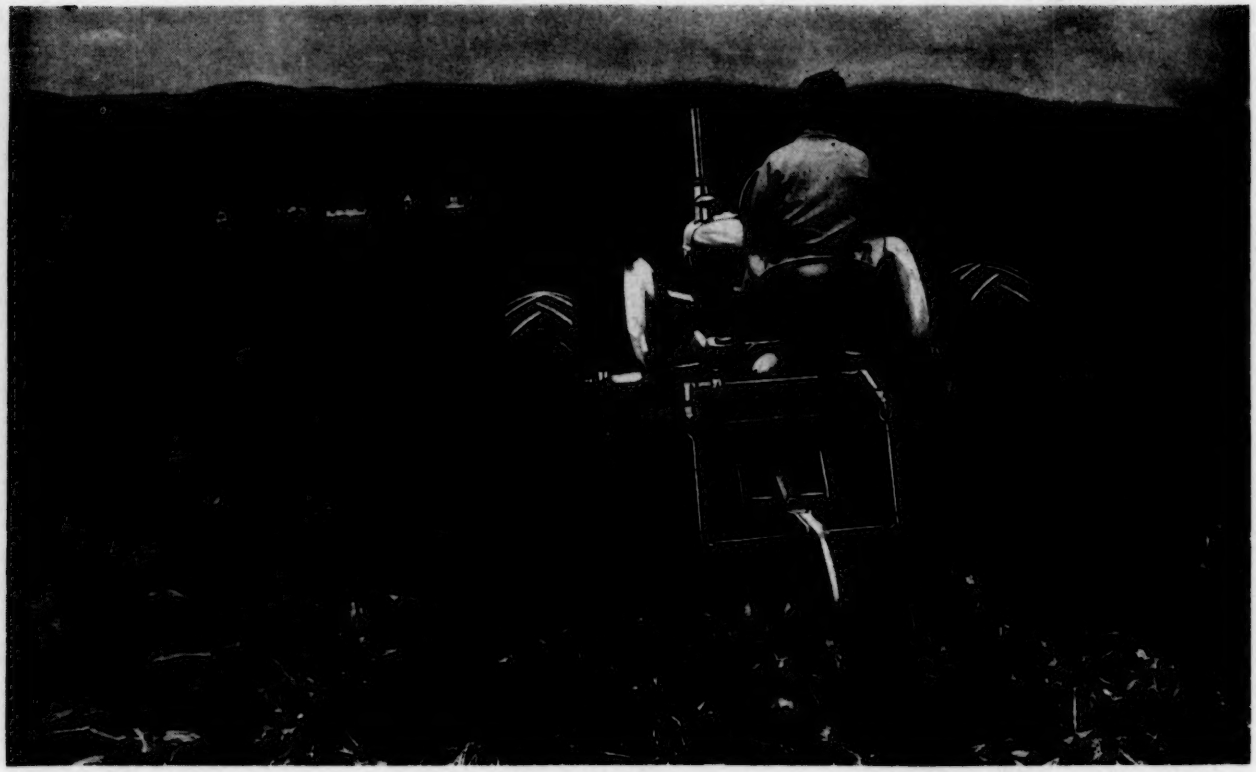

Give the Subsoil a Drink

Deep-rooted legumes are nature's own tools—and perhaps the best—for getting surface water into the subsoil.

But on the older cultivated lands, plow pans and tight subsoils are sure to be a problem for many years ahead.

Now a method of aiding nature mechanically is being used in humid areas after having proved successful on semi-arid and irrigated lands. The subsoiler pictured above on the Allis-Chalmers WD Tractor penetrates up to 18 inches or more and shatters hard layers of soil. Spaced at regular intervals across the slope, the chisel incisions catch water and lead it into the subsoil. On flat or marshy land the subsoiler can be used to improve drainage.

Allis-Chalmers subsoilers for the WD and CA Tractors make this phase of soil and water conservation practical for every farm. The Traction Booster system enables these farm-size tractors to handle the heavy pulling required for this type of work. Subsoiling is another conservation practice that can be done now with home-owned equipment.

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